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THE NORTH CAROLINA GEOLOGICAL SURVEY

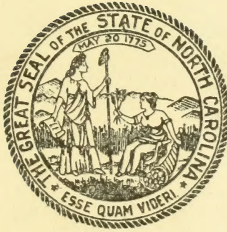
JOSEPH HYDE PRATT, STATE GEOLOGIST.

Economic Paper No. 12.

INVESTIGATIONS RELATIVE TO THE SHAD
FISHERIES OF NORTH CAROLINA

BY

JOHN N. COBB.



RALEIGH:

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., August 1, 1906.

To His Excellency, HON. ROBERT B. GLENN,

Governor of North Carolina.

SIR:—I herewith have the honor to submit for publication as Economic Paper No. 12 a report on the Investigations Relative to the Shad Fisheries of North Carolina. This report is supplemented by charts and tables which show the condition of this fishery in North Carolina for 1906, location of nets and the yield of fish. This paper has been especially prepared for the use of the committee who are investigating the general condition of all the fishing industries of North Carolina.

Yours obediently,

JOSEPH HYDE PRATT,

State Geologist.

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PREFACE.

At the request of the North Carolina Geological Survey, the United States Bureau of Fisheries, through Hon. George M. Bowers, its Commissioner, detailed Mr. John N. Cobb as special agent to investigate the shad fisheries of North Carolina for the season of 1906. About seven weeks were spent in the field in examining the location of nets, taking account of the run and catch of shad, and making notes on the general fishing conditions in all the sounds and rivers flowing into them.

The condition of the fishing industry in 1906 is compared with previous years, and shows that this particular fishing industry is on a decline in North Carolina, and that unless some steps are taken to remove the causes, it would be but a few years before the shad-fishing industry would be at a very low ebb, if not a thing of the past.

This report is published as an Economic Paper of the North Carolina Geological Survey, with the permission of the United States Bureau of Fisheries, in order that it could be made of more use in connection with the deliberations of the committee recently appointed by the Geological Board to investigate the general condition of all fishing industries throughout eastern North Carolina.

JOSEPH HYDE PRATT,
State Geologist.

INVESTIGATIONS RELATIVE TO THE SHAD FISHERIES OF NORTH CAROLINA.

By JOHN N. COBB.

INTRODUCTION.

Pursuant to orders dated March 3, 1906, directing me to make certain investigations relative to the shad fisheries of North Carolina for the season of 1906, I left Washington on March 5, and, beginning my work on the Cape Fear River, I worked northward, visiting all the rivers and sounds where shad are caught.

Complete data covering the apparatus used in the fisheries were secured, but as the season was not yet at an end in any part of the State, only general information in regard to the catch of shad was secured covering the period up to the time of my visit.

For some seasons the shad fisheries of the State show a remarkable decrease, as is clearly evidenced by the table given herewith (Table I). In this table the catch of shad in each form of apparatus is shown for each year for which data are available. According to this table the fisheries gradually increased from 1880 to 1897, but from that time on the decline was much more rapid than the increase had been, as by 1904 the catch had dropped to practically what it was in 1880. In the seine fisheries 1896 was the banner year, when 2,131,864 pounds were secured. The decline was very rapid, however, as by 1904 the catch amounted to but 345,046 pounds. The most productive year for gill-nets was 1897, when 4,916,952 pounds were secured, but in 1904 the catch had dropped to 1,147,268 pounds. In 1887 the pound-net catch amounted to 389,921 pounds, but by 1897 it had increased to 2,328,585 pounds. In the face of a remarkable increase in the number of nets set since 1897 the catch decreased from season to season until in 1904, when the quantity secured in pound-nets was 1,647,897 pounds. The catch in minor apparatus reached its maximum in 1896 when 245,268 pounds were secured. By 1904 the yield in this apparatus had decreased to 89,548 pounds.

TABLE I.—*Showing for certain years the catch of Shad in each form of apparatus used in the fisheries of North Carolina.*

Years.	Seines.			Gill-Nets.			Pound-Nets.			Minor Apparatus.			Total.	
	Number.	Pounds.	Value.	Number.	Pounds.	Value.	Number.	Pounds.	Value.	Number.	Pounds.	Value.	Pounds.	Value.
1880	-----	-----	\$-----	-----	-----	\$-----	-----	-----	-----	-----	-----	-----	920,360	3,221,263 \$329,569
1887	-----	1,619,012	98,136	-----	2,562,381	166,224	-----	389,921	24,429	-----	101,850	5,846	1,356,064	4,746,226 298,089
1888	-----	1,731,863	83,763	-----	3,338,352	179,945	-----	433,259	21,631	-----	127,225	7,070	1,608,774	5,693,429 295,029
1889	-----	1,618,798	81,580	-----	3,179,821	167,470	-----	385,517	21,648	-----	172,250	9,500	1,530,394	5,356,386 280,198
1890	-----	1,844,729	98,457	-----	3,348,577	175,388	-----	404,359	22,513	-----	170,748	9,657	1,612,594	5,768,413 306,015
1896	532,966	2,131,864	90,899	1,027,597	4,465,746	222,990	478,531	2,009,830	90,690	57,710	245,268	12,664	2,096,804	8,842,708 417,243
1897	-----	1,507,242	60,235	-----	4,916,952	205,079	-----	2,328,585	88,283	-----	210,709	9,204	2,170,800	8,963,488 362,811
1902	-----	996,181	59,605	-----	3,660,410	218,860	-----	1,701,609	93,185	-----	208,524	13,158	1,641,681	6,566,724 384,808
1904	87,214	345,046	30,810	285,516	1,147,268	104,010	432,060	1,617,897	168,449	20,865	89,548	9,681	825,555	3,229,759 312,950

	1902.		1904.	
	Pounds.	Value.	Pounds.	Value.
Flor	1,819,431	\$124,760	-----	\$-----
Geor	1,029,050	75,189	-----	-----
Sout	434,183	20,782	-----	-----
Nort	6,566,724	384,808	3,229,759	312,950
Virg	-----	-----	7,419,899	439,625
Mary	-----	-----	2,912,249	159,772
Dela	-----	-----	951,020	67,928
Penr	-----	-----	835,544	52,472
New	-----	-----	4,337,907	238,517
New	-----	-----	498,119	36,826
Conn	479,780	26,003	-----	-----
Rhod	30,786	2,465	-----	-----
Mass	21,247	1,137	-----	-----
Main	848,999	28,959	-----	-----
New	-----	-----	-----	-----
T	-----	-----	-----	-----

TABLE II.—Showing by States the catch of Shad for certain years.

State.	1880.		1887.		1888.		1889.		1890.		1891.		1896.		1897.		1901.		1902.		1904.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Florida	251,700	\$ 20,136	-----	\$-----	1,448,000	\$ 89,630	2,051,033	\$ 98,439	2,654,022	\$104,283	-----	\$-----	1,298,605	\$ 62,589	1,011,180	\$41,572	-----	\$-----	1,819,431	\$124,760	-----	\$-----
Georgia	252,000	17,941	255,200	18,760	263,200	19,000	356,352	27,000	399,660	30,918	-----	-----	536,627	49,289	787,550	46,705	-----	-----	1,029,050	75,189	-----	-----
South Carolina	207,600	12,432	365,772	22,840	432,800	27,050	577,457	42,696	563,259	41,187	-----	-----	671,513	33,436	506,125	27,696	-----	-----	434,133	20,782	-----	-----
North Carolina	3,221,263	329,569	4,746,226	298,069	5,630,709	292,409	5,356,386	280,198	5,768,413	306,015	-----	-----	8,842,708	417,243	8,963,488	362,811	-----	-----	6,566,724	384,808	3,229,759	312,950
Virginia	3,171,953	134,496	*3,815,126	172,272	8,106,823	376,944	-----	-----	7,266,207	228,897	6,498,242	207,394	11,170,519	307,055	-----	-----	6,972,212	366,203	-----	-----	7,419,899	439,625
Maryland	3,759,426	140,326	†4,040,820	146,951	5,595,735	218,230	-----	-----	7,127,486	242,909	6,224,873	211,575	5,541,499	166,551	-----	-----	3,111,181	120,602	-----	-----	2,912,249	159,772
Delaware	1,050,000	52,500	1,270,492	47,629	1,389,216	51,999	1,498,653	64,903	1,797,218	66,812	1,500,196	64,699	1,993,294	69,260	-----	-----	1,367,952	56,605	-----	-----	951,020	67,928
Pennsylvania	559,600	27,980	1,423,952	76,175	1,387,200	76,942	2,752,572	125,717	2,898,551	131,226	2,692,864	128,274	2,501,143	79,445	-----	-----	2,982,868	124,328	-----	-----	835,544	52,472
New Jersey	750,000	35,000	6,494,957	308,147	6,523,447	307,411	10,423,572	372,543	10,622,719	409,659	10,225,455	443,438	13,909,826	340,056	-----	-----	14,031,002	475,202	-----	-----	4,337,907	238,517
New York	2,733,600	136,680	3,585,740	131,477	3,445,639	150,882	4,332,532	217,988	3,776,975	190,180	3,044,956	161,209	2,200,546	74,833	-----	-----	3,432,472	110,682	-----	-----	498,119	36,826
Connecticut	1,318,032	65,902	377,090	23,718	232,077	18,427	195,852	16,580	-----	-----	-----	-----	261,190	14,082	-----	-----	-----	-----	479,780	26,003	-----	-----
Rhode Island	48,100	2,405	16,700	1,247	17,400	1,213	16,650	1,149	-----	-----	-----	-----	52,761	3,590	-----	-----	-----	-----	30,786	2,465	-----	-----
Massachusetts	164,524	8,226	132,519	4,750	260,086	7,613	234,324	7,362	-----	-----	-----	-----	114,152	3,236	-----	-----	-----	-----	21,247	1,137	-----	-----
Maine	580,319	11,876	1,095,720	27,330	839,256	24,368	887,800	18,687	-----	-----	-----	-----	1,404,477	30,778	-----	-----	-----	-----	848,999	28,959	-----	-----
New Hampshire	6,417	321	30	4	80	3	88	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Total	18,074,534	995,790	-----	-----	35,621,668	1,662,121	-----	-----	-----	-----	-----	-----	50,498,860	1,651,443	-----	-----	-----	-----	-----	-----	-----	-----

* Potomac and James Rivers not included.

† That portion of the Potomac River in Maryland is not included.

ies of No

-Nets.

Value. P

Cape	
Bel	\$-----
Ab	-----
Bla	-----
No	-----
Paml	46,050
Ne	
E	6,930
A	-----
C	-----
I	-----
Pa	18,520
T	-----
Pu	3,060
Croa	20,000
Roar	4,300
Curr	-----
Albe	76,100
No	700
Pa	4,400
Lit	1,300
Pe	6,800
Ye	2,600
Ye	-----
Ch	52,900
Ro	-----
	243,660

TABLE III.—Statement, by Water Areas, of the Apparatus Employed in the Shad Fisheries of North Carolina in 1896, 1904 and 1906.

Waters.	1896.												1904.												1906.														
	Drift Gill-Nets.			Stake and Anchored Gill-Nets.			Pound-Nets.		Seines.			Minor Apparatus.		Drift Gill-Nets.			Stake and Anchored Gill-Nets.			Pound-Nets.		Seines.			Minor Apparatus.		Drift Gill-Nets.			Stake and Anchored Gill-Nets.			Pound-Nets.		Seines.			Minor Apparatus.	
	Number.	Length. Yards.	Value.	Number.	Length. Yards.	Value.	Number.	Value.	Number.	Length. Yards.	Value.	Number.	Value.	Number.	Length. Yards.	Value.	Number.	Length. Yards.	Value.	Number.	Value.	Number.	Length. Yards.	Value.	Number.	Value.	Number.	Length. Yards.	Value.	Number.	Value.	Number.	Length. Yards.	Value.	Number.	Value.			
Cape Fear River and tributaries:																																							
Below Black River-----	113	21,010	\$ 3,634			\$-----		\$-----			\$-----		\$-----	90	19,680	\$ 3,205	175	2,100	\$ 710		\$-----		\$-----		\$-----	110	29,830	\$ 4,895	500	6,070	\$ 1,180		\$-----		\$-----		\$-----		
Above Black River-----	99	2,692	691						5	346	322	124	330	89	2,478	604						2	100	75	43	113	85	2,256	442					5	625	475	65	140	
Black River-----									21	630	436	60	150	26	1,440	286						26	985	700	61	148	28	2,720	544					22	612	670	31	91	
North East River-----	12	1,520	410						17	902	481			13	1,097	200						12	560	335			13	990	200					17	910	770			
Pamlico Sound-----				24,808	458,524	30,001	171	13,885								40,000	714,780	57,786	474	46,050									19,483	255,442	29,409	678	68,005						
Neuse River and tributaries:																										20	2,200	60	3,232	64,640	3,513	170	19,850	17	5,100	3,340	15	45	
Below Contentnea River-----	38	4,280	676	3,240	64,809	3,686	87	10,378	86	18,880	6,361	185	530	10	940	150	3,600	65,725	4,166	77	6,930	13	3,790	1,410	26	78							8	530	435	117	334		
Above Contentnea River-----				6	132	18			12	826	331	257	705				12	220	16			7	460	230	170	459			48	480	72		4	255	245	8	800		
Contentnea River-----				178	1,804	241			10	623	383	70	178				100	1,060	113			7	460	300	44	121			3	30	5								
Little River-----									2	130	78	17	48																										
Pamlico River-----	23	2,300	197	840	16,800	985	27	3,325	40	18,035	6,933	22	66	12	1,240	146	1,315	25,032	1,174	90	18,520	16	9,135	3,365	12	34	12	1,200	120	1,500	30,000	1,925	165	16,500	12	7,600	3,950		
Tar River-----									10	1,246	806	98	239									11	1,320	755	174	417							9	1,630	1,100	60	120		
Pungo River-----																				34	3,060											24	2,160						
Croatan Sound-----				5,625	108,420	7,516	140	10,825	1	2,300	3,000						2,550	43,900	3,825	200	20,000								1,478	26,604	2,012	190	18,275						
Roanoke Sound-----				225	4,500	281	3	300									1,950	35,100	2,925	43	4,300								270	5,400	270	46	2,300						
Currituck Sound-----																																2	200						
Albemarle Sound-----				21,985	432,488	29,944	612	56,215	4	10,000	12,500						12,909	265,240	22,862	714	76,100	3	7,450	14,000					13,215	297,591	30,724	661	71,700	3	7,650	13,913			
North River-----																				14	700											13	650						
Pasquotank River-----				100	1,800	125	17	1,550	4	4,650	3,630	10	20				20	360	20	44	4,400											47	4,700						
Little River-----																	40	720	60	26	1,300	1	100	25								22	1,100						
Perquimans River-----				765	14,295	1,032	71	6,075	2	2,300	2,600						210	3,780	315	136	6,800								240	4,320	360	147	7,350						
Yeopim River-----																				52	2,600											46	2,300						
Yeopim Creek-----																																5	250						
Chowan River-----	74	1,440	185				447	29,530	8	9,740	12,600			99	1,782	248	60	1,200	90	833	52,900	4	4,400	5,600			102	1,836	255	120	2,160	180	872	62,720	3	2,200	1,500		
Roanoke River-----	18	1,440	270	15	300	45			8	6,059	6,100	510	2,640	7	420	10						8	5,575	6,800	126	1,090	8	480	12				9	6,575	8,000	114	983		
Total-----	377	34,682	6,063	57,787	1,103,872	73,874	1,575	132,083	230	76,658	56,561	1,353	4,806	346	29,077	4,849	62,941	1,159,217	94,062	2,837	243,660	110	34,335	33,595	656	2,460	378	41,512	6,528	40,089	782,737	69,650	3,088	278,060	109	33,687	34,398	410	2,513

	Apparatus.		Total.	
	ber.	Value.	Number.	Value.
Cape				
Bel----	\$-----		48,487	\$ 14,749
Abc620	585		7,989	2,952
Bla300	846		10,449	3,778
Nor-----			6,442	2,353
Paml-----			347,293	139,343
Neu				
B360	529		33,738	10,474
A324	1,280		4,526	1,728
C771	260		3,191	1,178
L-----				
Par480	575		40,671	12,728
T520	1,270		5,442	2,004
Pur-----			3,864	1,251
Croat-----			77,758	34,261
Roane-----			4,285	1,990
Alber-----			178,886	64,650
Nor-----			700	295
Pas-----			1,230	442
Litt-----			890	389
Per-----			12,250	4,010
Yeo-----			4,000	1,280
Cho-----			18,754	6,226
Roa90	4,336		14,810	6,869
65	9,681		825,555	312,950

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TABLE IV.—Statement, by Water Areas and Apparatus, of the Number and Value of Shad Taken in North Carolina in 1896 and 1904.

Waters.	1896.												1904.											
	Drift Gill-Nets.		Stake and Anchor Gill-Nets.		Pound-Nets.		Seines.		Minor Apparatus.		Total.		Drift Gill-Nets.		Stake and Anchor Gill-Nets.		Pound-Nets.		Seines.		Minor Apparatus.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Cape Fear River and tributaries:																								
Below Black River	45,372	\$11,333		\$		\$		\$		\$	45,372	\$11,333	41,170	\$12,464	7,317	\$ 2,285		\$		\$		\$	48,487	\$ 14,749
Above Black River	5,375	1,584					668	200	6,719	1,658	12,762	3,442	6,229	2,314					140	53	1,620	585	7,989	2,952
Black River							3,745	958	2,385	609	6,130	1,567	4,424	1,553					3,725	1,379	2,300	846	10,449	3,778
North East River	4,062	1,033					6,989	1,589			11,051	2,622	2,192	763					4,250	1,590			6,442	2,353
Pamlico Sound			387,236	96,249	60,853	13,478					448,089	109,727			121,616	47,745	225,677	91,598					347,293	139,343
Neuse River and tributaries:																								
Below Contentnea River	18,485	3,244	23,118	3,811	22,471	3,902	105,210	19,222	12,250	2,901	181,534	33,080	800	280	18,514	5,500	7,392	1,983	5,672	2,182	1,360	529	33,738	10,474
Above Contentnea River			824	208			6,108	1,340	11,067	2,599	17,999	4,147			206	78			996	370	3,324	1,280	4,526	1,728
Contentnea River			2,541	661			2,573	633	1,919	437	7,033	1,731			910	338			1,510	580	771	260	3,191	1,178
Little River							186	44	300	65	486	109												
Pamlico River	5,221	1,139	8,114	1,632	7,759	1,538	32,178	6,161	1,010	209	54,282	10,679	3,700	1,133	6,576	1,914	19,075	5,797	9,840	3,309	1,480	575	40,671	12,728
Tar River							6,515	1,278	6,285	1,359	12,800	2,637							1,822	734	3,620	1,270	5,442	2,004
Pungo River																	3,864	1,251					3,864	1,251
Croatan Sound			68,626	14,006	73,834	13,925	20,000	3,800			162,460	31,731			4,898	2,165	72,860	32,096					77,758	34,261
Roanoke Sound			5,000	1,084	2,081	386					7,081	1,470			1,560	749	2,725	1,241					4,285	1,990
Albemarle Sound			429,599	82,664	173,380	32,094	132,213	25,401			735,192	140,159			61,954	23,293	69,848	24,665	47,084	16,692			178,886	64,650
North River																	700	295					700	295
Pasquotank River			1,000	190	2,840	460	4,642	893	275	56	8,757	1,599			130	57	1,100	385					1,230	442
Little River															350	148	450	203	90	38			890	389
Perquimans River			12,424	2,380	12,718	2,417	7,680	1,502			32,822	6,299			1,750	650	10,500	3,360					12,250	4,010
Yeopim River																	4,000	1,280					4,000	1,280
Chowan River	500	97			122,595	22,490	60,450	11,835			183,545	34,422	750	430	250	83	13,869	4,295	3,885	1,418			18,754	6,226
Roanoke River	4,000	480	6,100	1,195			143,809	16,043	15,500	2,771	169,409	20,489	220	68					8,200	2,465	6,390	4,336	14,810	6,869
Total	83,015	18,910	944,582	204,080	478,531	90,690	532,966	90,899	57,710	12,664	2,096,804	417,243	59,485	19,005	226,031	85,005	432,060	168,449	87,214	30,810	20,865	9,681	825,555	312,950

Unfortunately, the decrease in the shad fisheries has not been confined to North Carolina alone, as is amply evidenced by the table on page 10, in which is shown for certain years the quantity and value of shad produced in each State on the Atlantic coast in which the shad fisheries are prosecuted. When data for certain States are not presented it indicates that the fisheries of that State were not canvassed by the Bureau for the year in question. According to Table II, all States, with the exception of Florida, Georgia, and Rhode Island (none of which have been canvassed since 1902, since which year the greatest decreases appear to have occurred), show large decreases since 1896, the fisheries of New Jersey alone having dropped from 13,909,826 pounds in 1896 to 4,337,907 pounds in 1904, a decrease of 7,571,919 pounds.

The two preceding tables (III and IV) show by water area the apparatus employed in the shad fisheries of North Carolina for the years 1896, 1904, and 1906; also the catch by each form of apparatus in 1896 and 1904. The most notable feature of the first table is the increasing use of pound-nets in the fisheries. In 1896 there were 1,575; in 1904, 2,837; and in 1906, 3,088. In 1896 there were 57,787 stake and anchored gill-nets employed in the shad fisheries. By 1904 the number had increased to 62,941, but by 1906 it had dropped to 40,089. Seines show a heavy decrease, having dropped from 230 in 1896 to 110 in 1904 and 109 in 1906. These tables have been discussed more in detail under the respective headings of the water areas.

In the following pages the condition of the shad-fishing industry along the various rivers and sounds is taken up under each river and sound, beginning with the Cape Fear River and its tributaries and extending northward.

CAPE FEAR RIVER AND TRIBUTARIES.

This is the most southern river which is wholly within the State. The main Cape Fear is navigable to Fayetteville, 145 miles from the ocean. This is also about the limit of the commercial fisheries for shad. In showing the data gathered during the season of 1906 the river has been divided into two sections—the Wilmington section, from the mouth of the river to the entrance of Black River, 15 miles above Wilmington, and the upper section, from the Black River to several miles above Fayetteville—for the purpose of comparison with the previous years.

THE WILMINGTON SECTION.

In this section drift and stake gill-nets are employed exclusively.

The stake-nets are restricted to the east side of the river in New Hanover County, and as they must not approach the western shore nearer than a half mile, and are prohibited above the entrance of Brunswick River, they are practically confined to that section of the river between its mouth and the entrance of the Brunswick River. Although nets have in previous seasons been set as high as a little above the upper end of Campbell Island, in 1906 the uppermost net was located one mile above Doctors Point, while the lowermost net was set off the eastern end of Battery Island, near the mouth of the river. The greater part of the nets are between Federal Point and Doctors Point, where the river is the widest. According to law, the following rules prevail in setting these nets:

"They shall begin at a point 100 yards from the edge of the channel on the east side of said river and, running thence due east 120 yards, then leaving a gap of 120 yards. Then from the east end of said gap another net may be set 120 yards only, and to continue in the same proportion, always requiring a gap of 120 yards to intervene between each 120 yards of nets so set, and no net or sets of nets of any kind shall be placed opposite said gaps, within a distance of a half mile of same, and none of the nets so set shall be nearer than a half a mile of the west shore of said Cape Fear River."

The set-nets operated are about 12 yards long, with $5\frac{1}{2}$ -inch stretch mesh, and about 50 meshes deep. The largest number owned by any one man was 75. About two-thirds of the nets are in the water at one time, the others being on shore to be dried, cleaned, and repaired. Considerable complaint is made that the set-netters do not work their nets often enough, and as a result the fish are eaten by eels and crabs or washed out of the nets at the change of the tide. During 1906, 500 set-nets, with a total length of 6,070 yards, and a value of \$1,180, were set. This was an increase of 325 over 1904. None were operated in 1896.

Drift-Nets.—In this section of the river drift-nets are operated from a short distance above the Quarantine Station to Dollison, $1\frac{1}{2}$ miles below the mouth of Black River. Below Wilmington, where the river is much wider than above, the nets range from 200 to 425 yards in length, have $5\frac{1}{2}$ -inch stretch mesh, and are from 40 to 60 meshes deep. Above Wilmington they are about 150 yards long, with $5\frac{1}{2}$ -

inch stretch mesh, and are 60 meshes deep. The drift-nets operated in the Brunswick River (this being a thoroughfare about 12 miles in length which leaves the Cape Fear River about 4 miles above Wilmington and re-enters it 4 or 5 miles below that city) average 130 yards in length, with 5½-inch stretch mesh, and are from 30 to 40 meshes deep. During 1906, 110 drift-nets, with a total length of 29,830 yards, and valued at \$4,895, were operated in this section, as compared with 90 nets operated in 1904 and 113 in 1896. In the latter year, however, much shorter nets were employed.

According to law, no drift-net longer than 300 yards can be operated in this section of the river; but this appears to be "more honored in the breach than in the observance" in the portion below Wilmington. The same is true of the law forbidding the catching of "any fish in the waters of the Cape Fear River from its mouth to the Bladen County line * * * between six o'clock P. M. on Tuesday and six o'clock P. M. on Wednesday." While I was in Wilmington (in March) the fishermen were much exercised over a rumor that the authorities of Brunswick County were going to enforce the law, but those on the New Hanover County side seemed to have no fear on that score.

One bad feature of the drift gill-netting below Wilmington is that the nets are run too close together and cover too much of the channel.

The total catch of shad in this section of the river, including also the North East River below Three Cypresses, for certain seasons has been as follows: In 1889, about 70,000 fish; in 1890, 60,695; in 1891, 55,976; in 1896, 49,434; and in 1904, 48,487. In the latter year 41,170 shad were taken in drift-nets and 7,317 in set-nets. In 1890, 108 drift-nets were employed; 115 in 1891; 125 in 1896; 90 in 1904, and 115 in 1906. This gives an average per net of 562 shad in 1890; 487 in 1891, 363 in 1896, and 457 in 1904. As the catch of set-nets is available for one season only (1904), no comparisons can be made in regard to it.

Up to the time of my departure from this river (about the middle of March) but few shad had been secured. Most of the dealers and fishermen thought the season up to that time had been better than the season of 1905 during the same period, but all seemed to be agreed that the 1905 season was the worst they had ever experienced. Advances received as late as April 28 are to the effect that the season as a whole has been better than that of 1905.

FROM BLACK RIVER TO FAYETTEVILLE.

In this section of the river bow-nets and drift gill-nets predominate. In 1906, 85 drift-nets of a total length of 2,256 yards, and valued at \$442; 65 bow-nets, valued at \$140; and 5 seines with total length of 625 yards, and valued at \$670, were employed. The drift-nets were from 24 to 30 yards in length, with $5\frac{1}{2}$ -inch stretch mesh, and were about 22 meshes deep. The bow-nets in use were about 8 feet in diameter. The haul-seines averaged about 125 yards in length. The principal drift-net regions are from Kelley Cove to Elizabethtown, a distance of 35 miles, and from Finney's Bluff to Fayetteville, a distance of about 106 miles. In 1896 the lowest seine-beach on this river was at Prospect Hall, but in 1906 three were operated below this point—one each at Lloyds Landing, Grays Point, and Gastons Landing. At Prospect Hall two seines are operated in the busy season, one following closely after the other at the one shore. No seine-shores were operated above Prospect Hall in 1906, although in 1896 there were 3 in operation. The Powers fishery, located a short distance above Fayetteville, which was operated for a number of years, was abandoned several years ago upon the death of its owner, Mr. E. P. Powers. Above Fayetteville a few drift-nets, finger-traps, and bow-nets are operated occasionally, but mainly for home consumption, and no effort was made to secure data as to their number, etc.

In this section of the river in 1896 gill-nets took 5,375 shad; seines, 668, and bow-nets, 6,719—a total of 12,762. In 1904 gill-nets secured 6,229 shad; seines, 140; bow-nets, 1,620—a total of 7,989, thus showing a decrease, as compared with 1896, of 4,773 shad.

Up to and during my stay on this river very few fish were being taken by the fishermen in gill-nets, while the seines were unable to operate owing to the high water which had prevailed for some time.

It is against the law for any person to use more than one seine at any shore on the northeast branch of the Cape Fear River, and I would recommend that the same be made to apply to the Cape Fear itself.

BLACK RIVER.

This river, which flows into the Cape Fear about 15 miles above Wilmington, is quite narrow, ranging in width from 350 feet near

the lower end to 100 feet 50 miles above. About 53 miles from its mouth the South or South Black River enters it. But few shad go up the South River, however. About 84 miles from its mouth the Black River receives the Six Runs, up which there is a considerable shad run each season. Lisbon, 85 miles from the mouth, is the head of navigation during high water. As there are no falls on the Black River, shad can ascend to the uppermost limits.

Drift gill-nets, seines, and bow-nets comprise the apparatus employed in the shad fisheries. The drift gill-net reaches are from the mouth to Point Caswell, about 20 miles, and from Herring Landing to Cauty Cove Landing, about 6 miles. In the former reach the nets are from 100 to 150 yards in length and in the latter are about 15 yards in length, all having a stretch mesh of $5\frac{1}{2}$ inches. The seines range from 25 to 40 yards in length. Most of these are hired out by the day to persons who may wish to secure a supply of shad for home use, the usual compensation being \$2 for either a night or a day. The bow-nets are operated mainly on the Six Runs. Owing to the lack of convenient markets the fishing on this river is very desultory. In 1896 there were operated 21 seines and 60 bow-nets; in 1904, 26 drift gill-nets, 26 seines, and 61 bow-nets, and in 1906, 28 drift gill-nets, 22 seines, and 31 bow-nets. In 1896 the catch with seines amounted to 3,745 shad, and with bow-nets 2,385, a total of 6,130. In 1904 the drift gill-net catch amounted to 4,424 shad; the seine catch to 3,725 shad, and the bow-net catch to 2,300—a total of 10,449, a gain of 4,319 over 1896. This gain is due almost entirely to the employment of drift gill-nets in 1904, none being used in 1896.

At present it is unlawful to operate fishing-gear in the Black River, within the limits of Pender County, "between six o'clock P. M. on Tuesday and six o'clock P. M. on Wednesday." It is also forbidden to fish "in that part of Black River in Sampson and Cumberland counties and below the Atlantic Coast Line Railway bridge, * * * otherwise than with hook and line." * * * It is also forbidden to operate nets in the Black River and its tributaries "between the 15th days of May and August of each year." These laws seem to be all that are needed on this river.

NORTH EAST RIVER.

This river, which is about 120 miles in length, rises in the northeast portion of Duplin County and empties into the Cape Fear at Wilmington. It is navigable for small steamers as high up as Hallsville, a distance of 89 miles. A few fishermen from Wilmington and points along the shore operate drift-nets from the mouth to Castle Hayne, a distance of 27 miles; these nets being about 150 yards in length, $5\frac{1}{2}$ -inch stretch mesh, and about 60 meshes deep. A few drift-nets are also operated in the vicinity of Rocky Point, about 35 miles from the mouth. The greater part of the fishing, however, is carried on with seines. These are operated from Krooms Bridge, 56 miles from the mouth, to Kornegays Bridge, a distance of 103 miles from the mouth. In 1896 there were operated on this river 12 drift gill-nets and 17 seines; in 1904, 13 drift gill-nets and 12 seines; and in 1906, 13 drift gill-nets and 17 seines. A number of seine-beaches have not been worked for some years now, owing to the scarcity of fish. In 1896 the number of shad taken in gill-nets was 4,062, and in seines, 6,989—a total of 11,051. In 1904 the catch of shad in gill-nets was 2,192, and in seines 4,250—a total of 6,442, or a decrease of 4,609. Up to the time of my visit to this river in March almost no fish had been taken, and what little had been secured were taken by gill-nets, as the river had been quite high for some time and the seines were unable to operate.

The following are the laws at present in force on this river:

“If any person shall fish in the northeast branch of the Cape Fear River with seine, net, or trap, from the twenty-third day of February to the first day of July of any year, between the hours of six o’clock P. M. on Saturday and six o’clock P. M. on Monday of each week, or shall at any time use more than one seine at a time in any fishing-hole in said river, or use, set, or place in said river any hedge, trap, or other obstruction which will prevent the free passage of fish up said river, which said hedge, trap, or other obstruction shall extend more than one-third across the main channel of the said river, he shall be guilty of a misdemeanor. This section shall not apply to that portion of said river which lies between the city of Wilmington and a point on said river known as The Three Cypresses, 12 miles distant from said city of Wilmington.”

In that portion of the North East River in Pender County, fishing with nets is prohibited "between six o'clock P. M. on Tuesday and six o'clock P. M. on Wednesday."

The destruction of fish by any means, except with hook and line, is prohibited in that portion of the North East River lying in New Hanover County "between the fifteenth days of May and August of each year."

There does not seem to be any necessity for additional laws covering the fisheries of this river.

PAMLICO SOUND.

Pamlico Sound is an irregularly shaped body of water running parallel to the coast line for about one-fourth of the length of the State, being separated from the ocean by a long, narrow sand-beach known as "The Banks." This sound is about 75 miles long, measured on a line drawn from the mouth of the Neuse River northeastward, the greatest width about 25 miles and the average width nearly 20 miles, the whole covering about 1,660 square miles. At the north end it communicates with Albemarle Sound through Roanoke and Croatan sounds, while on the south it joins Core Sound. Two large rivers, the Neuse and Pamlico, enter the sound from the west. Communication is had with the sea through Oregon, New, Hatteras, and Ocracoke inlets, each less than half a mile across. The greatest depth of water in the sound is 24 feet, but shoals, especially in the northeastern portion, are numerous. As the river water from about one-half of the State, and a part of Virginia, empties into Pamlico Sound, it counteracts the effect of the natural ebb and flow of the ocean tide, and as a result there are no tides in the sound except such as are produced by heavy winds. During the greater part of the year the waters of the sound are salt or brackish, but during the season of heavy rains the immense volume of water coming down from the rivers makes the water, except in the vicinity of the inlets, quite fresh.

Owing to its extremely favorable location, the shad fisheries of this sound are the most important in the State. By far the greater part of the fisheries are located in the northeastern portion, where the shoals are most numerous, east of a line drawn from Hatteras Inlet to Long Shoal Point, almost all of this area being within the

bounds of Dare County. The fishing is generally carried on from temporary camps scattered along and over the sound, the most important of these being Roanoke Marshes, Hog Island, Duck Island, Sandy Point, Rodmans, Baums Slew, Davis House, and Gull Island in Dare County, and Swan Point in Carteret County. The permanent settlements from which fishing is prosecuted are Stumpy Point, Englehard, Manteo, Rhodanthe, Avon, Buxton, Trent, and Hatteras, in Dare County, and Hobucken in Pamlico County.

Stake-nets and pound-nets were almost the sole apparatus used in the capture of shad in the sound in 1906, but 14 anchored gill-nets having been employed. Stake-nets average 18 yards in length, 6 to 16 feet deep, with $5\frac{1}{4}$ to $5\frac{1}{2}$ -inch stretch mesh, and are set in strings comprising a widely varying number. The greater part are set on the shoals in the eastern part of the sound, north of New Inlet, the Duck Island flats being the favorite spot from about 1894 to 1905, when the Vann law compelled the greater part of the nets set here to be removed. On these flats the depth averages 3 feet and in many places is so shoal that the fishermen can wade alongside the nets very easily, and thus remove the fish. The nets set in the sound are generally allowed to remain in the whole season, as they do not seem to rot or foul as in the fresh water. The season for gill-nets is generally from the first week in February to about the middle of April. The gill-netters of this region have had a number of disastrous seasons of late years, owing largely to the unusual clearness of the water; but up to the middle of March of the 1906 season gill-nets had secured nearly all of the few shad taken up to that time. As remarkably good prices were obtained for these, it is probable that the gill-netters ended the season with a balance on the profit side. During the season of 1906, 19,483 stake and anchored (14 of the latter style) gill-nets, with an aggregate length of 255,442 yards, and a total value of \$29,409, were used. In 1904, 40,000, and in 1896, 24,808 of these nets were operated. The drop of 20,517 in two years is partly explained by the operation of a new fishery law, which will be discussed farther on. These nets, in 1896, took 387,236 shad, while in 1904 but 121,616 shad were secured, a decrease of 265,620 fish, at the same time that there was an increase of 15,192 in the number of nets used. This gives an average of almost 16 shad to the net in 1896, and only 3 shad to the net in 1904—a most remarkable falling off.

During the season of 1906 fishing for shad with gill-nets was prosecuted for the first time off Swan Point, in Carteret County, by fishermen from Roe in the same county. Stake gill-nets to the number of 709 and 14 anchored gill-nets were used. The stake-nets were of the regulation kind operated in the sound, while the anchored nets were each about 100 yards in length, 5½-inch stretch mesh, 40 meshes deep, and cost about \$15 each. A fairly profitable season was had.

The pound-nets in this region cost about \$100 each. The "pound" is generally 10 yards square, the "heart" 45 yards on each side, and the "leader" from 50 to 350 yards long. The mesh in the "pound" is 2¼ inches, in the "heart" 3 inches, and in the "leader" 4 inches. A number of fishermen, however, operate what are known as "shad-pounds," the only difference being in the wider mesh of the different parts, in order that herring and other small fish may pass through. They are generally set from the shore in strings of from 1 to 10, but during the last few seasons a number have been set along the outer line of shoals in the northeastern part of the sound. The pound-nets in this sound have been steadily increasing in number for some years. In 1896, 171 were in use; in 1904, 474, while in 1906 the number had increased to 678—a gain of 507 in ten years. The catch of shad in pound-nets in 1896 was 60,853 in number, while in 1904 it amounted to 225,677 fish—a gain of 164,824. In 1896 the average catch of shad per net was 355, while in 1904 it was 476, thus showing a real gain. The season of 1906 was an exceptionally poor one for the pound-netters, owing to the muddy water, the fishermen claiming that shad will not enter the nets in any number unless they are able to see the leader distinctly.

The Legislature in 1905 passed the following law, commonly known as the Vann law, the greater part of which applies exclusively to Pamlico Sound:

Dutch-Nets in Pamlico and Albemarle Sounds.—If any person shall set or fish any net, seine, or appliance of any kind for catching fish at any place within a radius of two and one-half miles either way from Roanoke Marshes light-house at a distance more than five hundred yards from the shore of Roanoke Island or the mainland on the western side of Croatan and Pamlico sounds; or shall set or fish any pound or dutch-net on the eastern side of Pamlico Sound within ten miles of the Roanoke Marshes light-house, except such as shall be fished within five hundred yards of the Roanoke Island or Hog Island shores; or shall set or fish any dutch or pound-net on the eastern side of Pamlico Sound more than two thousand yards west of a

line running south-southeast from Big Island to Bulkhead or shoal west of Chicamacomico or south of said point more than two thousand yards from the shoals as marked on the United States Government chart, made from data obtained to November twenty-second, one thousand nine hundred and four, or shall set or fish any dutch or pound-net on the west side of Pamlico Sound in said sound extending into the water more than two thousand yards from the shore of the mainland; or shall set or fish any pound or dutch-net in Croatan Sound further from the shore than one-fifth the width of said sound at that point; or shall set or fish any pound or dutch-net in the Albemarle Sound more than two thousand yards from the shore of the mainland, or in Chowan River further from shore than one-third the width of said river at place where said nets are fished or set, or within one-fourth mile of any wharf used by a steamer on said river; or shall set or fish any net or appliance of any kind for catching fish within one mile on north or south side of a line five miles long running west from center of New Inlet or Oregon Inlet, or on north or south side of a line five miles long running northwest from center of Hatteras Inlet, he shall be guilty of a misdemeanor and be fined or imprisoned in the discretion of the Court. The provisions of this section shall apply only to that part of each year beginning January fifteenth and ending May fifteenth. The place of trial for offenses under this section shall be the county opposite where the act was committed. It shall be the duty of the Oyster Commissioner or Assistant Oyster Commissioner, whenever an affidavit is delivered to him stating that the affiant is informed and believes that this section is being violated at any particular place, to go himself or send a deputy to such place, investigate same, and he shall seize and remove all nets or other appliances setting or being used in violation of this section, sell same at public auction and apply proceeds of sale to payment of cost and expenses of such removal, and pay any balance remaining to the school fund of county nearest where offense is committed.

This law, owing to its radical provisions and its far-reaching effect upon a population devoted almost exclusively to fishing, has met with considerable opposition as regards certain provisions, in Dare County, to which it mainly applies.

The provision forbidding the setting of nets "within one mile on the north or south side of a line 5 miles long running west from center of New Inlet or Oregon Inlet, or on north or south side of a line 5 miles long running northwest from center of Hatteras Inlet" meets with almost unanimous approval. Part of this unanimity may be due, however, to the fact that at both Oregon and New Inlets the channels, a mile or two inside of the inlets, swing to the southeast and leave the closed area, and gill-nets set along them prove quite profitable, while at Hatteras Inlet the channel leaves the closed area about $1\frac{1}{2}$ miles inside of the inlet, and as there is a shoal just east of the line, the fish are forced out towards Hatteras Inlet light where

the pound-nets are located. With the exception of Hatteras Inlet, no pound-nets have, in recent years, been located in this restricted area, but large numbers of gill-nets were set in the vicinity of New and Oregon Inlets, and these have all had to be removed outside the line. As gill-net fishing had been unprofitable for several seasons, a number of the dispossessed fishermen abandoned this form of fishing altogether this season.

Other provisions which meet with general approval are those forbidding the setting of nets in Pamlico Sound off the Roanoke Island or Hog Island shores, or more than 2,000 yards from the mainland shore on the western side of the sound. A glance at the two charts (for 1904 and 1906) showing the nets set in the first-named area will show the absolute necessity of the law in question. In 1904 the mouth of Croatan Sound was almost entirely blocked by the strings of pound-nets set off the Marshes shore, around Buntings and Big Islands, and in Pamlico Sound a few miles off the Hog Island shore. As nearly all of the shad going north pass through Croatan Sound, this arrangement of nets virtually cut off the fish from the fishermen of Croatan and Albemarle sounds and the tributaries of the latter. Under the present law this passage is left entirely free, and it should be the first aim of the State to keep it so.

I found some objection to the provision forbidding the setting of nets "within a radius of two and one-half miles either way from Roanoke Marshes light-house at a distance more than 500 yards from the shore of Roanoke Island or the mainland on the western side of Croatan and Pamlico sounds." Under this provision those fishermen who had been setting their nets in the bays just south and north of the Marshes, within the restricted area, found themselves cut off by the long strings set just without the bounds. As the general desire was to prevent the setting of long strings in the narrow section where Pamlico and Croatan Sounds meet, no harm could result if the strings north and south of the Marshes were allowed to extend out in an easterly direction to the outer edge of the Marshes.

The chief objection I found to the law was as to the provision forbidding the setting of "any pound or dutch-net on the eastern side of Pamlico Sound within ten miles of the Roanoke Marshes light-house, * * * or shall set or fish any dutch or pound-net on the eastern side of Pamlico Sound more than 2,000 yards west of a line running south-southeast from Big Island to Bulkhead or shoal

west of Chicamacomico or south of said point more than 2,000 yards from the shoals as marked on the United States Government chart made from data obtained to November twenty-second, one thousand nine hundred and four." The principal point urged against this law was that it forced the fishermen so far down in the sound that they were compelled to employ power boats to go and return, while their employees had to work longer hours, and as a result many refused to work on these strings and sought employment with those better situated. As only a few nets can be set in the restricted area around the South end of Roanoke Island and Hog Island, and as the unrestricted areas in the vicinity were already occupied, some of the pound-netters have had to go as far south as Gull Island on the eastern side and to Middletown, in Hyde County, on the western shore. It is really questionable whether it is necessary for the preservation of the fisheries to block off such a large area. It should be stated, however, that a few fishermen (but none in the area affected) feel that this provision of the law is a necessary one. Should this area be thrown open again it might be well to hold the strings down to the 2,000-yard length, and also require that each string be set in practically a straight east and west line, with the hearts all opening in one direction. This would do away with the triangles and hooks now so popular, and give the shad a better chance for their lives.

Although stakes had been put in showing the restricted area to ten miles from the light, I found a number of strings set almost up to the $2\frac{1}{2}$ -mile area from the Roanoke Marshes light. A few fishermen lived strictly up to the law, very much to their financial loss. In the other restricted areas I found the law very generally obeyed.

The pound-netters south of Chicamacomico complain bitterly because of the law restricting them to 2,000 yards from the shoals. From Hatteras Inlet the "Banks" run in an almost due east course to Cape Hatteras, and from there they take a north and easterly course. The widest part of the sound is from the inside of Cape Hatteras to Long Shoal Point on the western shore, nearly 25 miles, and as the shoals on the eastern side do not extend out more than 6 or 7 miles, this leaves an area nearly 20 miles wide in which pound-nets cannot be set. The angle of the "Banks" makes a bight in this section in which shad are found in but slight numbers, as the fish from Hatteras Inlet go up the Sound some miles to the westward. But little, if any, damage would be done by remov-

ing all restrictions on the eastern side below Gull Island (except around Hatteras Inlet), as but few fishermen would set nets out near the middle of the sound, owing to the distance from camps and the danger of damage to their nets during the usually stormy spring months when fishing is carried on.

A few of the pound-net fishermen suggested to me that it would be much better for the shad fisheries if the pound-nets set in Pamlico and Croatan sounds were all of what is known as "shad-pound" mesh. This would allow the alewives and small fish to escape, and as the pound-netters in this region are after shad principally, not having the labor available to handle alewives profitably, it would allow all of the latter and also all other small fish to escape. If this were done in the fall it would allow the young shad to escape, and thus prevent the destruction now going on in the latter species during the fall fishing.

Some fishermen claim that shad frequently spawn in Pamlico Sound. While this might occur under unusual conditions, such as extreme freshness of the waters of the sound or long-continued cold winds from the northwest, it would be an exceptional occurrence under ordinary conditions, as is shown by the large numbers which go up into Albemarle Sound, the favorite spawning ground of the shad; also by the fact that the pound-netters report the catch of but few shad in a ripe condition.

An impression exists among some of the fishermen that shad winter in the sounds, and in confirmation of this they point to the fact that shad are very rarely seen going through the inlets, which would be an easy matter to observe in daylight, owing to the clearness of the water in these narrow places, and also that shad taken in gill-nets near the inlets are generally found with their heads pointing towards the ocean, thus showing that they had gilled on the far side of the net. This contention is not borne out, however, by the experience of those pound-netters who set their nets in the sound during the fall months. While quite young shad are frequently taken in these, it is rare to find a mature one in them. It is also probable that shad are not observed coming through the inlets, as at that time they have not yet begun to school, and it is also probable that many come through at night.

NEUSE RIVER AND TRIBUTARIES.

The Neuse River is formed in Durham County, N. C., by the junction of the Eno, Flat, and Little rivers, and from that point to New Bern is a distance, following the windings of the stream, of 260 miles. In the 40 miles of river below New Bern it widens very much and becomes virtually a broad arm of Pamlico Sound. Its principal tributaries are the Trent, Contentnea, and Little rivers. Formerly, shad ascended this river to its uppermost limits, and extensive fisheries are said to have existed near Raleigh, 190 miles from New Bern. At present, however, commercial fishing does not extend above Goldsboro, although considerable fishing for home use is prosecuted above that city. For purpose of comparison with the canvass of 1896 the shad fisheries of this river are divided into two geographical sections, viz.: (1) the lower, 72 miles from Pamlico Sound to Contentnea River, and (2) from Contentnea River to the headwaters.

FROM THE MOUTH TO CONTENTNEA RIVER.

From New Bern to the mouth, the river ranges in width from 6 to $1\frac{1}{2}$ miles, and from New Bern to the Contentnea it is from 250 to 80 feet wide at low water. The forms of apparatus used in this section of the river are seines, drift and stake gill-nets, pound-nets, and bow-nets. All but a few of the seines are operated at regular beaches, the others being hauled at places where it seemed fishing would be most successful. In 1896 there were 5 seines operated for shad on the river between New Bern and the mouth; in 1906 there was but 1 used. This seine was 1,000 yards in length, 14 feet deep, with stretch-mesh of $2\frac{1}{2}$ inches in the bunt, and from $2\frac{3}{4}$ to 3 inches in the balance. It was hauled by 6 men and 2 mules. The seine at Johnsons Point was operated at a loss in 1905 and then abandoned. Between New Bern and Cowpen Landing 9 seine-beaches (1 on Bachelors Creek), with 11 seines, were operated in 1906. At two of the beaches 2 seines each were operated in the busy season. The seines in this reach range from 150 to 300 yards in length. In the whole section from the mouth to Contentnea River there were 17 seines operated in 1906 as compared with 13 in 1904 and 86 in 1896. The catch of shad in these seines amounted to 105,210 in 1896 and 5,672 in 1904, a decrease of 99,538 fish.

The stake gill-nets used in the Neuse River are set in strings of about 20 each. They are each about 20 yards long, $5\frac{1}{4}$ -inch stretch mesh, 30 to 40 meshes deep, and cost about \$1. The favorite spots for stake-nets are just below the road bridge at New Bern, some of the nets being tied at one end to the piling of the bridge, between Upper Broad Creek and Goose Creek, off the mouth of Slocums Creek, and close to Cherry Point. In 1906, 3,232 of these nets were set; in 1904, 3,600; and in 1896, 3,240. In 1896 the number of shad secured in these nets was 23,118, and in 1904, 18,514, a decrease of 4,604. Usually these nets are operated until the early part of April, but at the time of my visit to the Neuse (about the middle of March) nearly all that had been set in the lower reaches of the river had been taken out, owing largely to the small catch up to that time and to the ravages of crabs. This form of apparatus was interdicted by law for many years.

Drift gill-nets are operated generally between Bachelor Creek, 4 miles above New Bern, and Thoroughfare, $9\frac{1}{2}$ miles from New Bern. These nets averaged about 110 yards in length, with stretch mesh of $5\frac{1}{4}$ inches. In 1906, 20 drift-nets were used; in 1904, 10; and in 1896, 38. The number of shad taken in this form of apparatus in 1896 was 18,485, while in 1904 but 800 were secured, a decrease of 17,685.

The pound-net was first introduced in the Neuse River about 1878. In 1880, 6 were reported, and by 1896 this number had increased to 86, set on both sides of the river. In 1904 there were 77 in use, all located on the north side of the river in Pamlico County, a law forbidding their use elsewhere on the river. The "leads" to these nets average about 200 yards in length, and the mesh in the traps is from 2 to $11\frac{1}{2}$ inches. They are usually put in the water in August or September and allowed to remain in until May. The number of shad taken in this form of apparatus in 1896 was 22,471, and in 1904 it amounted to but 7,392, a decrease of 15,079. There was also a decrease of 10 in the number of nets employed.

Only 15 bow-nets were used in this section in 1906 as compared with 26 in 1904 and 185 in 1896. The catch of shad in this form of apparatus in 1896 was 12,250, while in 1904 the number taken amounted to but 1,360, a decrease of 10,890.

The season of 1906 was somewhat better than that of 1905, but even then shad were quite scarce as compared with the earlier seasons. This year what fish did come up the river appeared late in the season. Alewives were also more plentiful than in 1905, which was a very bad season.

FROM CONTENTNEA RIVER TO GOLDSBORO.

In this stretch of river during 1906, 8 seines and 117 bow-nets were employed in the shad fisheries, as compared with 12 stake gill-nets, 7 seines, and 170 bow-nets in 1904; and 6 stake gill-nets, 12 seines, and 257 bow-nets in 1896. In the last-named year the canvass was extended to the headwaters, which explains the large number of bow-nets for that year. Seines were operated in 1906 as far up the river as Bear Creek, 69 miles from New Bern. The catch of shad in this stretch of river in 1896 was as follows: In stake-nets, 824; in seines, 6,108, and bow-nets, 11,067. In 1904 the catch of shad by apparatus was as follows: In stake-nets, 206; in seines, 996; in bow-nets, 3,324. All show a decrease for 1904 as compared with 1896.

CONTENTNEA RIVER.

This river enters the Neuse about 32 miles above New Bern, is 140 miles long, and is navigable as far as Stantonsburg, 63 miles above the mouth. The apparatus used in taking shad in this river consists of seines, stake gill-nets, and wheels. The seines run from 30 to 85 yards in length, with mesh from 2 to $3\frac{1}{2}$ inches. The stake-nets average about 10 yards in length, with mesh of $5\frac{1}{2}$ inches, and are set between Gaskins and McCarters landings. There were also 8 wheels in operation a few miles above and below Stantonsburg. In this latter fishery rows of saplings sunk in the stream and banked with brush are run out from both banks until they are within about 5 feet of each other. In this narrow opening the wheel is placed. This comprises two broad frameworks, like paddles, to which net-bags are attached, the whole looking like two dip-nets attached to an axle. By means of a rude sort of windlass attached to the axle, the paddles are turned by hand, and as the current aids very materially when one of the paddles is in the water, it requires very little strength to operate. When not in use the axle is turned until both paddles are out of the water and then clamped in this position. This brings them so far above the surface that a rowboat can

pass under the paddles through the opening. As an appropriation has been secured for the improvement of the Contentnea, and these wheels were an obstruction to navigation, the United States engineer in charge of the work ordered their removal. They should be prohibited by law also.

In 1896 there were 178 stake gill-nets, 10 seines, and 70 bow-nets operated for shad; in 1904, 100 stake gill-nets, 7 seines, and 44 bow-nets, and in 1906, 48 stake gill-nets, 4 seines, and 8 wheels so operated. In 1896 the catch of shad by apparatus was as follows: In stake gill-nets, 2,541; in seines, 2,573, and in bow-nets, 1,919. In 1904 the catch of shad was as follows: In stake gill-nets, 910; in seines, 1,510, and in bow-nets, 771.

LITTLE RIVER.

About 2 miles above Goldsboro the Neuse receives the waters of Little River, which is nearly 100 miles long. No effort was made to cover this stream more than a few miles from its mouth, where some fishing was carried on by Goldsboro parties. Three stake gill-nets, 30 yards long, were set about $2\frac{1}{2}$ miles from its mouth.

RECOMMENDATIONS AS TO THE NEUSE RIVER AND TRIBUTARIES.

The use of two seines at the same time in one fishing-hole should be prohibited. The use of wheels should be prohibited. It seems to me that far too many stake gill-nets are set in the immediate vicinity of the road bridge at New Bern.

PAMLICO-TAR RIVER.

Pamlico River is only the estuary of the Tar River, the name changing just above the town of Washington. The Pamlico River portion has a length of 37 miles, with a maximum width of 4 miles and a minimum width of about 1-3 of a mile at Washington. The Tar River is 180 miles long, thus giving a total length for both portions of 217 miles. Tarboro, 49 miles above Washington, is the present head of navigation. Shad ascend as far as Rocky Mount, where a natural fall obstructs their farther advance.

By far the greater part of the fishing is prosecuted in the Pamlico River section, and drift and stake gill-nets, pound-nets, and seines are the forms of apparatus employed.

The 12 drift gill-nets used in 1906 averaged 100 yards in length and were operated in front of Washington.

The stake gill-nets are about 20 yards in length, 10 to 12 feet deep, with $5\frac{3}{8}$ to $5\frac{1}{2}$ -inch mesh, and about 20 are set in a string. They are scattered all along the river from Redmans Point to opposite Sinclairs Creek; Blount Bay and the vicinity of Mauls Point are the favorite spots for setting these nets. In 1896, 840 of these nets were used and took 8,114 shad. In 1904, 1,315 were employed, and took 6,576 shad. In 1906, 1,500 nets were set. This shows a constant increase in the number of nets, but a steady decrease in the catch. Sand-fleas were especially destructive to the nets during 1906, many of the nets being destroyed by them, and at the time of my visit (shortly after the middle of March) only a few strings were in the water.

Seines in the Pamlico River are operated from Mauls Point to the town of Washington. In 1906, 12 were operated in this section, 7 being on the south side of the river, 3 on the north side, and 2 being hauled to islands in the river. These seines range from 350 to 800 yards in length, with meshes from 2 to $2\frac{1}{2}$ inches. The season usually begins early in February below Washington, and about 2 weeks later in the upper portions of the river. In 1896, 23 seines were used on the Pamlico and took 32,178 shad; while in 1904, 16 seines were employed and took 9,840 shad, showing a decrease of 7 seines and 22,338 shad. In 1906, 12 seines were operated.

In 1896, 27 pound-nets were set near the mouth of the Pungo River. An interdiction existed against the use of this form of apparatus at that time, but it was "more honored in the breach than in the observance." In 1903 the Legislature authorized their use in the Pamlico River "below a line beginning on the southern shore of Pamlico River at Mauls Point, and running due north to a point on the northern shore of said river: *Provided*, that no dutch, pod, pyke, or pound-net, or other net of like kind, shall extend out in said river more than one-eighth of the distance across said river from the shore, and that none of said dutch, pod, pyke, or pound-nets shall be set, placed down, or fished nearer to each other than five hundred yards, measuring up and down the river; nor shall they be placed, set down, or fished within five hundred yards of any seine-beach in actual use for hauling a seine, nor within one mile of the mouth of Bath Creek: *Provided*, no nets of the kind enumerated in this

section, or other nets of like kind, shall be placed down, set, or fished in said rivers between the tenth day of May and the first day of July in any year." As there has been considerable objection to the use of pound-nets in this river, I made an especially careful examination of those set during the season of 1906, and am forced to confess that they seem to be less of an obstruction to the ascent of the shad than on any other river and sound where their use is authorized by law. No string has more than 4 nets upon it, while the majority have but 2 and 3, and the law about not running them out more than $\frac{1}{8}$ of the width of the river seems to be rigidly obeyed. The section forbidding the setting of these nets within 1 mile of the mouth of Bath Creek is not observed, however. During 1906, 165 pound-nets were set in the Pamlico River, but up to the time of my visit they, as well as the gill-netters, had caught very few shad. In 1904 there were 190 pound-nets set and these took 19,075 shad, a very small catch for such a large number of nets.

TAR RIVER.

From Washington to Greenville, a distance of 22 miles, 9 seine-beaches were operated in 1906. As the season had been so poor up to the time of my visit, one or two were in doubt about operating, but as they had made ready they have been included. The above is a decrease of 2 as compared with 1904, and of 1 as compared with 1896. These nets range in length from 100 to 400 yards. In 1896 the 10 seines secured 6,515 shad, while in 1904 the 11 seines secured 9,840, a gain of 3,325. Judging from the limited data obtainable the seines operated on the Tar River have held their own better than on any other river in the State.

Bow-nets are operated at favorable points above Washington. In 1896, 98 were operated; in 1904, 174; and in 1906, 60. The number of shad secured in these in 1896 was 6,285, and in 1904 was 3,620.

PUNGO RIVER.

The Pungo River is a short and broad tributary of Pamlico River. In 1896 there were set 24 pound-nets near the mouth of the river, a decrease of 10 as compared with 1904, when 34 were set. These nets are similar to those operated in the Pamlico River.

CROATAN SOUND.

This sound, which forms the principal means of communication between Pamlico and Albemarle sounds, is 10 miles long, $2\frac{1}{2}$ to 4 miles wide, and averages 8 to 10 feet deep, the bottom being very uneven. Roanoke Island forms its eastern shore and the mainland the western. Nearly all of the shad passing north from Pamlico Sound traverse Croatan Sound.

The pound-net is the only apparatus of importance set for shad. The western shore is lined with strings of nets, reaching out 1-5 the width of the sound, while but few are operated on the eastern shore. These are operated by people from Callahans Creek, Manns Harbor, and Peter Mashoes Creek on the mainland, and from Skyco on Roanoke Island. The nets are similar to those operated in the north-eastern end of Pamlico Sound. In 1896 there were 140 pound-nets operated in this sound; in 1904, 200; and in 1906, 190. The number of shad taken in these pound-nets in 1896 was 73,834, and in 1904, 72,860. The average number of shad per net in 1896 was 527, and 1904, 364, thus showing a very material decrease per net.

In 1906, 1,478 stake gill-nets, of the same length and style as those operated in Pamlico Sound, were set in Croatan Sound. The number of these set shows a steady decrease, as in 1896, 5,625 were set, and in 1904, 2,550. The former gill-netters are now most of them pound-netters. In 1896 the catch of shad in gill-nets numbered 68,626; while in 1904 the number had decreased to 4,898. The catch per net in 1896 was 13, while in 1904 it had decreased to slightly under 2 to the net.

ROANOKE SOUND.

Roanoke Sound runs parallel to Croatan Sound and is separated from the latter by Roanoke Island. It is about 10 miles in length, from 1 to 2 miles wide, and very shoal except in a narrow channel skirting the shore of the island. But few shad pass through Roanoke Sound, the favorite passage being Croatan Sound.

Only 270 stake gill-nets were set in this sound in 1906 and nearly all off the extreme northern end of the island. There were 46 pound-nets operated in the sound in 1906 and all but 2 of these were between Ballast Point and N. W. Point of Roanoke Island. In 1896, 225 stake gill-nets were operated; in 1904, 1,950, and in 1906, 270. The number of shad taken in these nets in 1896 was

5,000, and in 1904 the number was 1,560; the average per net in 1896 being 22, while in 1904 it was less than 1 to the net. In 1896, 3 pound-nets were set, and in 1904, 43. The catch of shad per net in 1896 was 694, but in 1904 it had dropped to 63 to the net.

ALBEMARLE SOUND AND TRIBUTARIES.

The magnificent sheet of water known as Albemarle Sound stretches east and west from the coast to a distance of nearly 60 miles, and is said to be the largest coastal body of fresh water in the world. In width it averages 7 or 8 miles and has an area approximating 450 square miles. The only tides on this sound are those caused by the winds, and these are of infrequent occurrence, while it is wholly free from strong currents. Its depth is quite uniform, averaging from 16 to 20 feet.

Stake and anchored gill-nets, seines and pound-nets are the forms of apparatus operated for shad. The principal fishing centers on the sound are Powells Point, Peter Mashoes Creek, Holloways Pier, Pear Tree Point, Leonards Point, Mackeys Ferry, and Edenton. Edenton, Hertford, and Elizabeth City are the principal shipping points.

The anchored gill-nets in 1906 numbered 299, with a total length of 39,150 yards, and a value of \$3,937. The greater part of these nets are set in the sound west of the Perquimans River. The only difference between these nets and stake gill-nets is that the former are anchored at each end instead of being secured by stakes, as is the case with the latter. The catch of these nets has been combined with the stake gill-net catch.

The stake-nets operated in this sound are of the same length and style as those described for Pamlico Sound. These nets are set principally on the south side of the sound between Laurel Point and the Alligator River, and on the north side east of Little River. The eastern end of the sound is also a favorite spot. In 1896, 21,985 of these nets (including anchored nets also) were set in the sound and they caught 429,599 shad, an average of $19\frac{1}{2}$ fish to the net, while in 1904, 12,909 nets were operated and caught 61,954 shad, or an average of about $4\frac{1}{2}$ fish to the net. In 1906 there were 13,215 (299 of which were anchored nets) in use, and owing to the muddy water they did fairly well. In 1896 the stake-net fishery was the

most important, but in 1904 the pound-net fishery had achieved the pre-eminence.

The pound-nets in Albemarle Sound are almost essentially the same as those in Croatan and Pamlico sounds. While quite a few are set between Peter Mashoes Creek and Durants Island, on the south side, and at Powells Point, at the eastern end, the great body of them are located in the western half, west of Little River on the north and the Scuppernong River on the south. Some of the longest strings in the State are located in this section. These nets were first introduced in Albemarle Sound in 1870. In 1880 there were 117 in use, in 1896 the number had increased to 612, in 1904 they numbered 714, and in 1906 there was a slight decrease, only 661 being set. The catch in 1880 was 920,360 shad, an average of 7,866 to the net; in 1896 the catch amounted to 173,380 shad, an average of 283 to the net; and in 1904, 69,848 shad were taken, an average of 98 to the net. The pound-nets did very poorly in 1906.

Until about 1860 haul-seines were the only form of apparatus used for shad, and for some years later they were the principal apparatus. Owing to the expense of operating them as compared with gill-nets and pound-nets, they gradually dropped off until in 1906 there were but 3 in operation on the sound—at Drummonds Point and Greenfield in Chowan County, and at Avoca in Bertie County. These seines are among the largest in the country, averaging 2,500 yards each in length. The meshes in the wings range from $2\frac{1}{2}$ to 4-inch stretch, and in the bunt 2-inch stretch mesh. The laying out of the seine is done by means of steam flats. In 1896 there were 4 seines operated on the sound and these secured 132,213 shad, or an average of 33,053 to the net. In 1904, 3 were operated and secured 47,084 shad, or an average of 15,694 shad to the net—less than $\frac{1}{2}$ of the average of 1896.

NORTH RIVER.

This is a short but comparatively wide river emptying into the eastern part of Albemarle Sound. In 1904, 14 pound-nets were operated in this river, and in 1906, 13. The catch of shad in 1904 was only 700, this river being frequented but little by this species.

PASQUOTANK RIVER.

This is really an arm of Albemarle Sound, extending 15 miles inland, with an average width of 2 miles and a depth of 10 or 12 feet. In 1896 there were 100 stake gill-nets, 17 pound-nets, 4 seines and 10 minor nets operated for shad; in 1904 there were 100 stake gill-nets and 44 pound-nets set, and in 1906, 47 pound-nets. In 1896 the catch of shad in stake-nets was 1,000; in pound-nets, 2,840; in seines, 4,642, and in minor nets, 275. In 1904 the catch in stake-nets was 130 shad and in pound-nets, 1,100. The run of shad in this river is slight and most of the above apparatus is set for alewives and other species, rather than for shad.

LITTLE RIVER.

This is quite a short stream emptying into the sound between the Pasquotank and Perquimans rivers. Shad go up it in limited numbers and the pound-nets set in it in 1906 were principally for other species. In 1904, 40 stake-nets, 26 pound-nets, and 1 seine took shad, while in 1906 there were but 22 pound-nets set during the shad seasons.

PERQUIMANS RIVER.

This is also an arm of Albemarle Sound, 12 miles long, and averaging over a mile in width. Next to the Chowan River this is the most important stream on the north side of the sound up which the shad ascend. In 1896, 765 stake-nets, 71 pound-nets, and 2 seines, caught some shad, the number taken in the stake-nets being 12,428, in the pound-nets 12,718, and in the seines 7,680, a total of 32,822. In 1904, 210 stake-nets took 1,750 shad and 136 pound-nets caught 10,500 shad, a total of 12,250, or a decrease of 20,572.

YEOPIM RIVER AND CREEK.

In 1904, 52 pound-nets set in the river caught 4,000 shad. In 1906 there were 46 pound-nets set in the river and 5 in the creek. Shad forms but a small part of the total catch of these nets.

CHOWAN RIVER.

The Chowan is formed by the junction of the Blackwater and Nottoway rivers nearly on the line between North Carolina and

Virginia. From the junction to its mouth is a distance of about 55 miles. For the lower 20 miles the river averages about $1\frac{3}{4}$ miles in width, and the water is dark and clear. For a few miles above Coleraine the greater part of the river is filled with stumps, while above Hollidays Island the river narrows very much. This river is most noted for its alewife fisheries, the shad catch being very small when one considers the quantity of apparatus used.

Seines, drift and stake gill-nets, and pound-nets are the only forms of apparatus used.

There were formerly a large number of seines on the river, but the unprofitableness of seine fishing, and the lesser cost of operating pound-nets, has led to the abandonment of many of them. In 1896 8 seines were operated and secured 60,450 shad, while 4 were operated in 1904 and secured but 3,885 shad, an average of 7,556 per net in 1896, and of 971 per net in 1904. In 1906 but 3 seines were operated, and all of these were above Hollidays Island.

The Chowan River has the largest number of pound-nets in use of any river in the country, the number in 1906 being 872. In 1896 there were 447 in operation, and in 1904, 833. There is a regular network of nets from the mouth to Tunis, occupying about 2-3 of the river. From Whites Landing to Hollys Wharf a large number are set in the middle of the river in addition to those running out from both shores. The law permits the pound-netters to run their strings out to 1-3 the width of the river. One string of 9 nets at Willow Branch came prominently to my notice, owing to the complaints of some of the fishermen that it extended out almost to the center of the river, and my eye observation bore out their complaint. In 1896 the 447 pound-nets caught 122,595 shad, an average of about 274 to the net; in 1904 the 833 nets secured 13,869 shad, an average of about 17 to the net.

A few stake gill-nets, similar to those in the sound, are set near the mouth. There were 60 of these in 1904 and 120 in 1906.

In the vicinity of the railroad bridge at Tunis 74 drift gill-nets were drifted in 1896, 99 in 1904, and 102 in 1906. They averaged 18 yards in length.

ROANOKE RIVER.

The Roanoke River is the principal tributary of Albemarle Sound, and is a narrow stream, with very rapid current. It rises in Virginia and from the confluence of the Dan and Staunton in Virginia is 198

miles to its mouth. The water of the Roanoke is very muddy and can be traced for many miles after emptying into the sound, by its dingy yellow color.

The commercial shad fisheries are confined quite largely to that portion of the river from the mouth to Williamston. The forms of apparatus employed are seines, bow-nets, drift gill-nets, and wheels.

The seines catch slightly more than $\frac{1}{2}$ of the shad obtained, although they formerly secured over 80 per cent. Seines are operated at Jamesville and from 2 miles above Plymouth to the mouth. The waters of the Roanoke debouch into the sound through three mouths—the Roanoke proper, Middle River and Cashi River combined, and the Eastmost River. Below Plymouth 2 of the fisheries are on the Roanoke, 1 on the Middle River, and 2 on the Cashi River. In 1896, 8 seines were operated and secured 60,450 shad, an average of 7,556 to the net; while in 1904, 8 seines secured 8,200 shad, an average of 1,025 to the net. In 1906, 9 seines were operated. The presence of so many nets near the mouth of such a narrow stream as the Roanoke would appear on the surface as excessive, but nature has put such limits upon their operations as amply protect the stream itself. Freshets are quite frequent on the river, and when these occur it is impossible to operate the seines, thus permitting the shad an unobstructed passage up the river.

A few gill-nets, 18 in 1896, 7 in 1904, and 8 in 1906, are drifted in the vicinity of Plymouth, but the fishery is very insignificant now, 4,000 shad having been secured in 1896 and but 220 in 1904.

A number of wheels are operated close to shore on both sides of the river, but as they only extend out about 12 feet they do no damage to the shad fisheries. A number of bow-nets are also fished at various places along the river as far up as Weldon. In 1896 there were 510 wheels and bow-nets operated and these caught 15,500 shad. In 1904, 126 were operated and caught 6,390 shad. In 1906, 114 were operated.

SCUPPERNONG AND ALLIGATOR RIVERS.

On the south side of the sound are the Scuppernong and Alligator rivers, in which are carried on extensive pound-net fisheries for alewives, but the number of shad which enter these rivers is exceedingly small, so these nets have not been included in the tables.

The shad fisheries of Albemarle Sound and its tributaries are in a very bad way at present. If this were a temporary condition, due to local adverse conditions prevailing for one, or possibly, two seasons, it might be hoped that matters would soon adjust themselves, and the fish return in as great numbers as formerly; but all information available points steadily in one direction, viz., the shad are not caught in anything like such abundance as say, from five to ten years back, simply because they are not in North Carolina waters to be caught. The fishermen of the sound are thoroughly awake to this fact, and are seeking a remedy. Unfortunately, they have cast their eyes away from home, as is but human, and have failed to notice, or blinded themselves to the conditions prevailing in their own vicinity. For a time the great cry was to "clear the inlets!" The inlets were thoroughly clear last season, and there was but little to prevent the shad from ascending if they so desired, and what was the result? A season as bad, if not worse, than the preceding ones. It is useless to contend that the fishermen in Dare County are solely to blame for the present depleted condition of the fisheries; the blame lies almost as much upon the fishermen of western Albemarle Sound and its tributaries. During the season of 1906 the fishermen of Albemarle Sound and its tributaries operated 1,813 pound-nets, more than were operated in the whole of Virginia in 1904. The greater part of this large number of pound-nets is massed in the western end of the sound and in the Chowan River, on the principal spawning beds. Far be it from me to recommend the abolishment of the pound-net, which can ill be spared in this age of advancement; but something must be done to reduce the enormous number now being set in the sound and its tributaries if it is ever hoped to build up the shad fisheries again. Not content with running out the numerous strings of pound-nets in the narrow portion of western Albemarle, many of the owners also set out long strings of anchored gill-nets in the portions of the sound where pound-nets are not permitted. It would possibly be well to abolish the anchored gill-net altogether in this sound. Such a prohibition would fall but lightly on the fishermen, as nearly all of the owners of such nets are also pound-netters. The conditions in the eastern section of the sound are not so bad as in the western, as but few nets are set in this section, and it is also much wider than the other.

The alewife fishery, which is very important on this sound and its tributaries, is also in bad shape, the decrease in this species being as marked as in that of the shad. As the greater part of these are taken in pound-nets and seines, with the shad, anything that will benefit the shad fisheries will work also for the benefit of the alewife.

GENERAL RECOMMENDATIONS.

ENFORCEMENT OF THE LAW.

As the law is at present constituted, it is quite difficult of enforcement in many instances. The procedure to be followed under the more important clauses is as follows: Some person must make an affidavit that he is informed and believes that the law is being violated at some particular place. This affidavit must be delivered to the Oyster Commissioner or Assistant Oyster Commissioner, whose duty it shall be "to go himself or send a deputy to such place, investigate same, and he shall seize and remove all nets or other appliances setting or being used in violation of this section, sell same at public auction and apply proceeds of sale to payment of cost and expenses of such removal, and pay any balance remaining to the school fund of the county nearest to where offense is committed." One of the most serious objections to this method of procedure is that in a strictly fishing community the odium attached to informing against violators of the fishing laws would prevent a person from making such an affidavit as required above unless he was being directly injured by the violation. Another objection is that the burden of prosecuting the suit is imposed upon the Oyster Commissioner. At present this official is compensated from a fund made up of license fees paid by the oystermen, and the latter object most decidedly to the oyster fees being diverted to the protection of the fisheries, which contribute not one penny towards this fund. The law provides, of course, for the payment of the expenses of suit out of the sale of the offending apparatus, but if the owner should fight the matter in the courts the expense of litigation might exceed the amount realized from such sale if the suit resulted in favor of the State, while if the suit is decided in favor of the fishermen the whole expense of the suit would be saddled upon the oyster fund. This is not just to the oystermen, as all of the license fees paid by them, over and above what is expended in the compensation of officials appointed to en-

force the oyster laws, is supposed to be expended in the direct work of bettering the condition of the oyster beds.

What the State of North Carolina needs is a commission of one or more practical men appointed for the sole purpose of conserving its fisheries. The fisheries of the State are of vast importance to its prosperity and too much cannot be done to foster them. During my investigation I found an almost unanimous sentiment in favor of such a commission, and a quite general willingness on the part of the fishermen to support it by means of license fees, as is now being done in the case of the oyster fishery.

EARLY CLOSING OF SEASON.

At present shad fishing is permitted on the Cape Fear River as late as May 15th; in Pamlico County on the Neuse River until May 1st, and along the balance of the river until May 15th, while dutch or pound-nets are allowed in the Pamlico River until May 10th. Throughout the rest of the State there are practically no restrictions upon the length of time the shad fishermen shall work. It is, of course, obvious that the late runs of shad comprise the ripest females, and these are the ones which should receive the most protection. After the middle of April there is but little profit to the fishermen in shipping shad, as the northern markets are then well supplied with fish from Chesapeake and Delaware bays, and the price is necessarily quite low. If these late shad were permitted to spawn unmolested by man they would undoubtedly benefit the fishery wonderfully, and I would recommend that this be done. The fishermen along the upper reaches of the river could be permitted to work from a week to ten days longer than those near the mouths or in the sounds, as it would take about that length of time for the last run upon which the latter had worked to reach the upper courses of the rivers. I would suggest the following basis upon which to work:

Cape Fear River.—All shad apparatus below the mouth of Black River to be out by April 20th; all above this point to be out by May 1st.

Northeast Cape Fear River.—All shad apparatus below Castle Hayne to be out by April 20th, and all above that point to be out by May 1st.

Black and other tributaries of the Cape Fear River.—All shad apparatus to be out by May 1st.

Neuse River.—All shad and alewife apparatus operated at or below the town of New Bern to be out by April 20th, and all above that town to be out by May 1st.

Pamlico and Pungo River.—All shad and alewife apparatus to be out by April 20th.

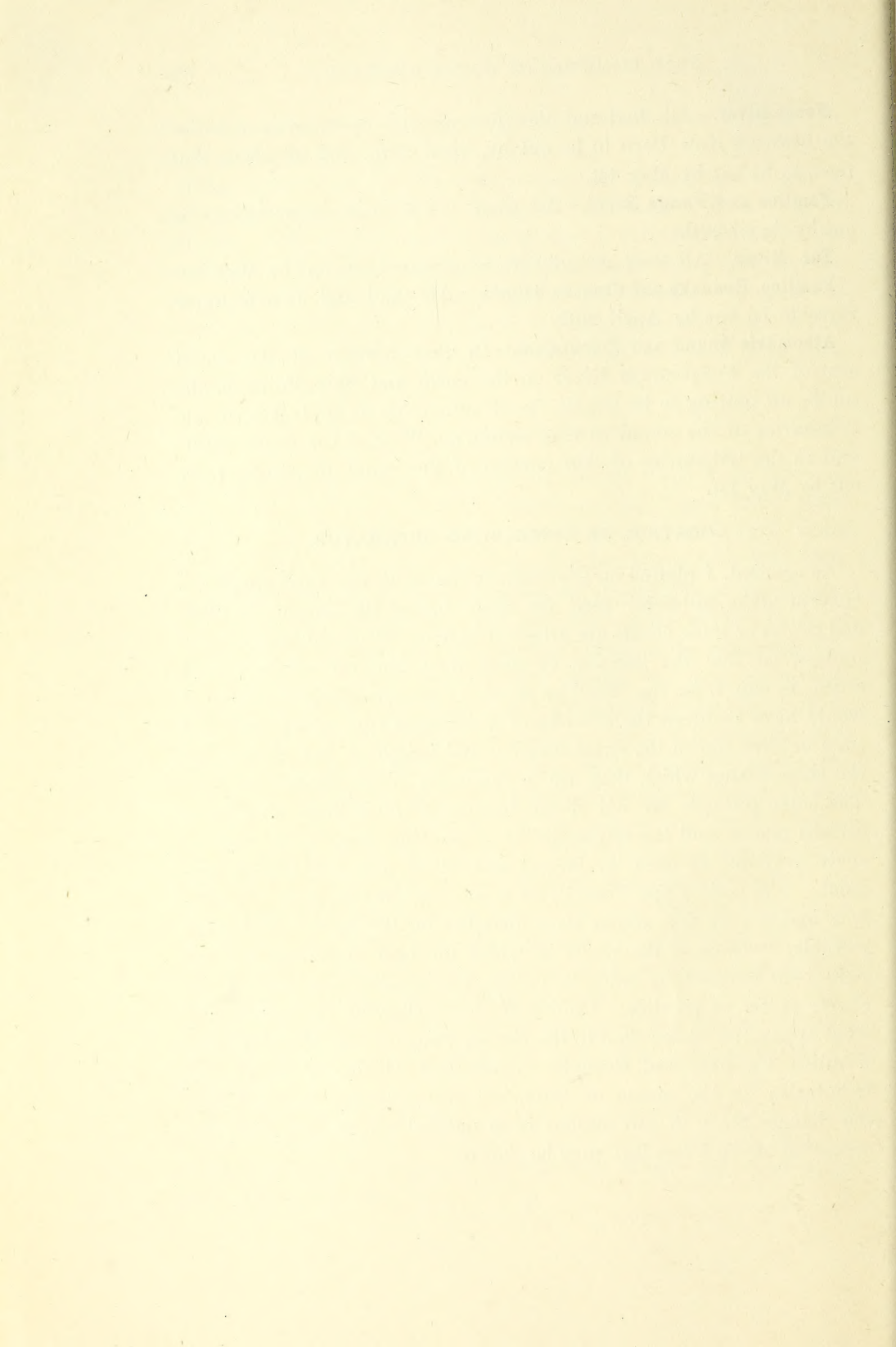
Tar River.—All shad and alewife apparatus to be out by May 1st.

Pamlico, Roanoke and Croatan Sounds.—All shad and alewife apparatus to be out by April 20th.

Albemarle Sound and Tributaries.—In that portion of the sound east of the Perquimans River on the north and Ship Point on the south, all netting to be out by April 20th (this to apply also to the tributaries of the sound in this section). West of the above points and in the tributaries of that portion of the sound all netting to be out by May 1st.

LOCATION OF FIXED SHAD APPARATUS.

As ordered, I plotted on government charts all the fixed apparatus (except stake gill-nets) used for shad during the season of 1906, and copies of these charts are attached hereto. It should be distinctly understood that the location of these nets, and the distance each string is run from the shore or shoal, is merely approximate, as it would have required the services of a surveyor and a long period of time to have shown the exact location and length of each string, and the time during which they are in the water is too limited for that. The stake gill-nets are not shown because of their large number in certain places, and the impossibility of plotting them in the limited space available on even the largest scale chart issued by the government. The main Cape Fear River is not included because only gill-nets and a very few seines were operated on the river. Whenever possible, sections of the rivers in which no fixed apparatus was set have been omitted in order to reduce the number and size of the charts as far as possible. Copies of charts showing the location of fixed apparatus set for shad in the Neuse, Pamlico, and Pungo rivers, Pamlico, Croatan, and Roanoke sounds, and Albemarle Sound and tributaries for the season of 1904, are also included in order that the changes made in two seasons from natural causes, and from the operation of the Vann law, may be shown.



PUBLICATIONS OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*
2. Building Stone in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill. *In press.*
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4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
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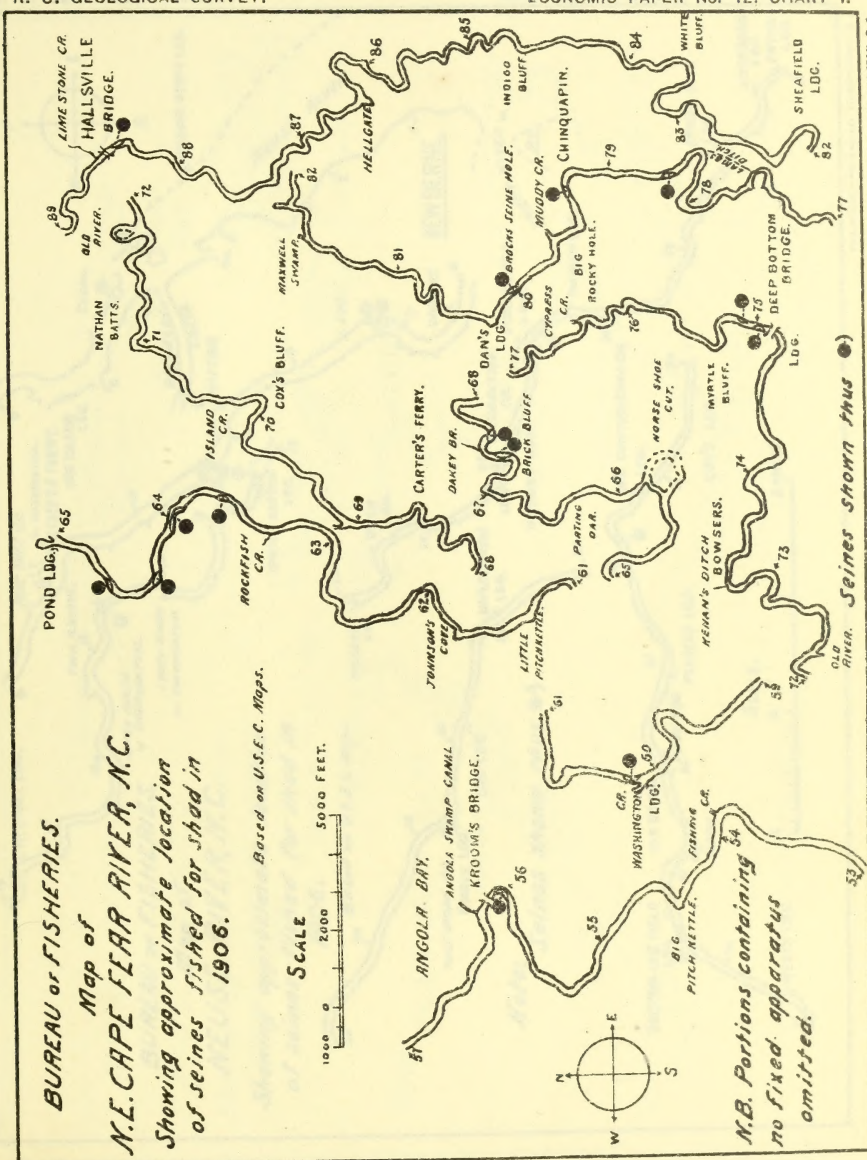
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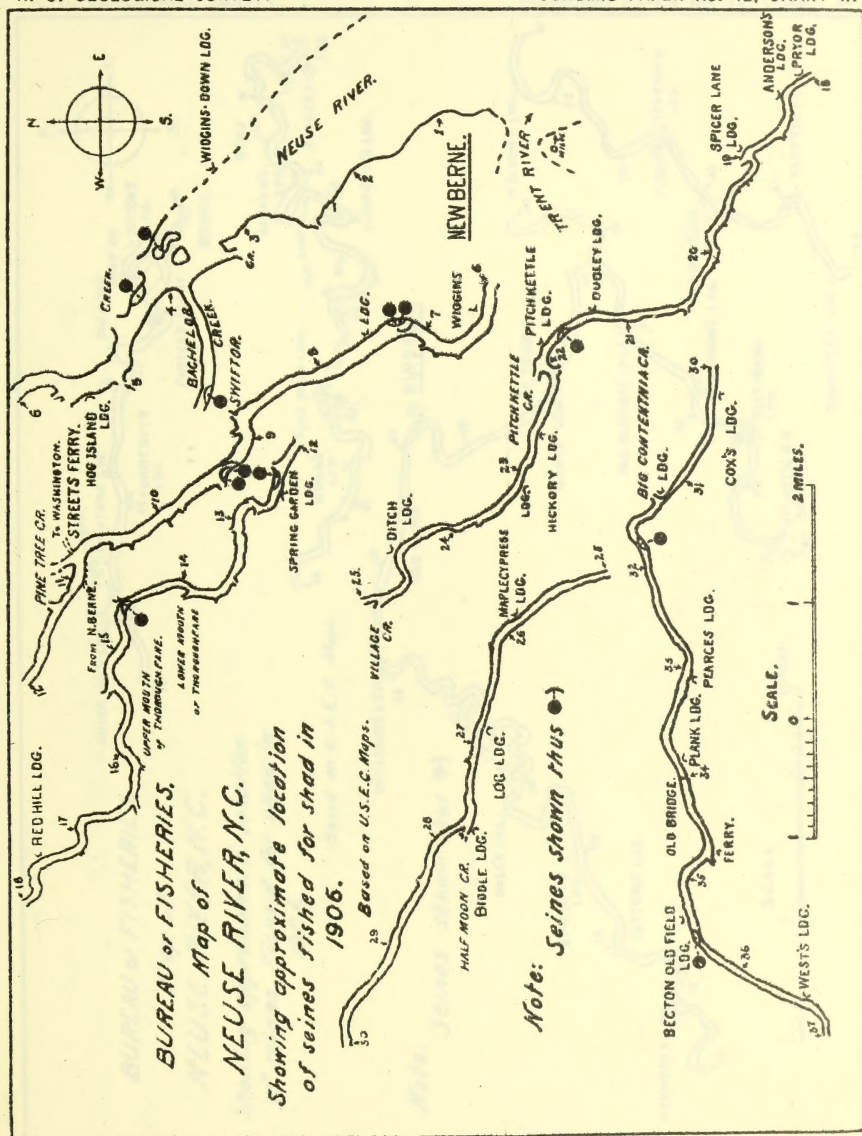
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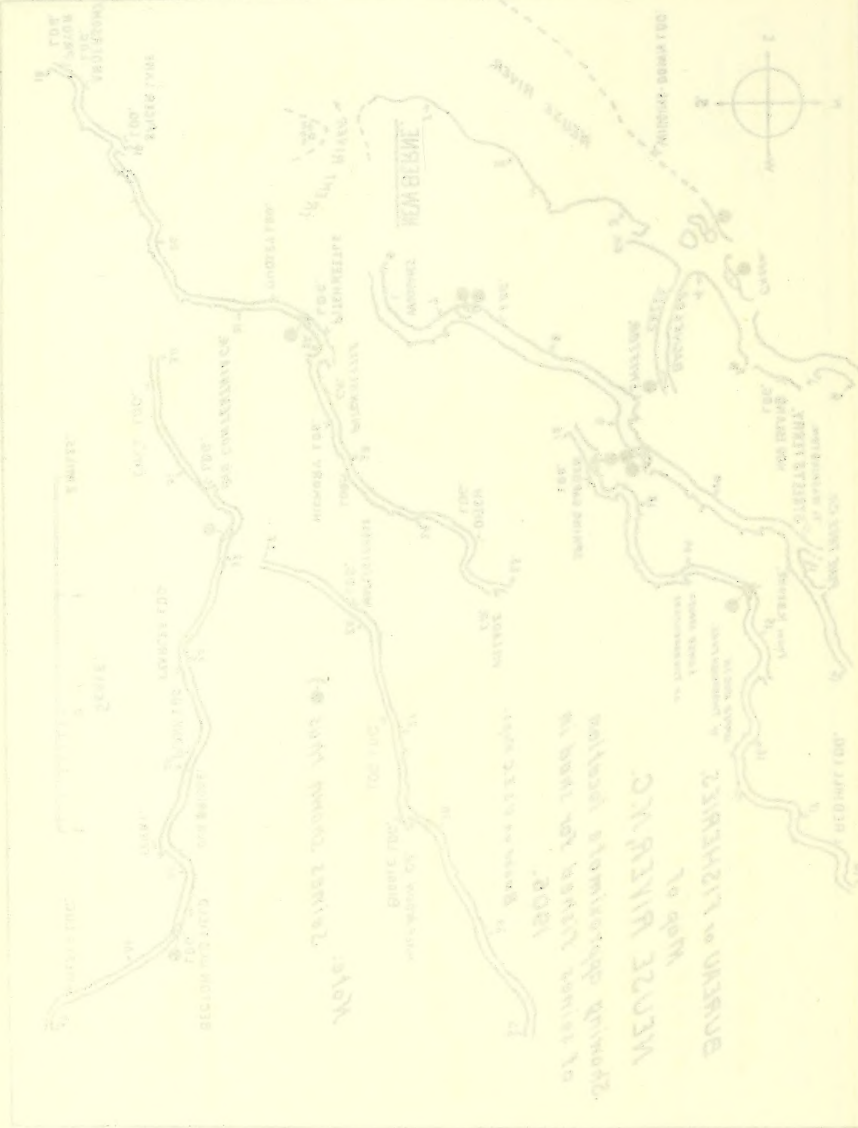
- Vol. 1. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis. *Postage 32 cents.*
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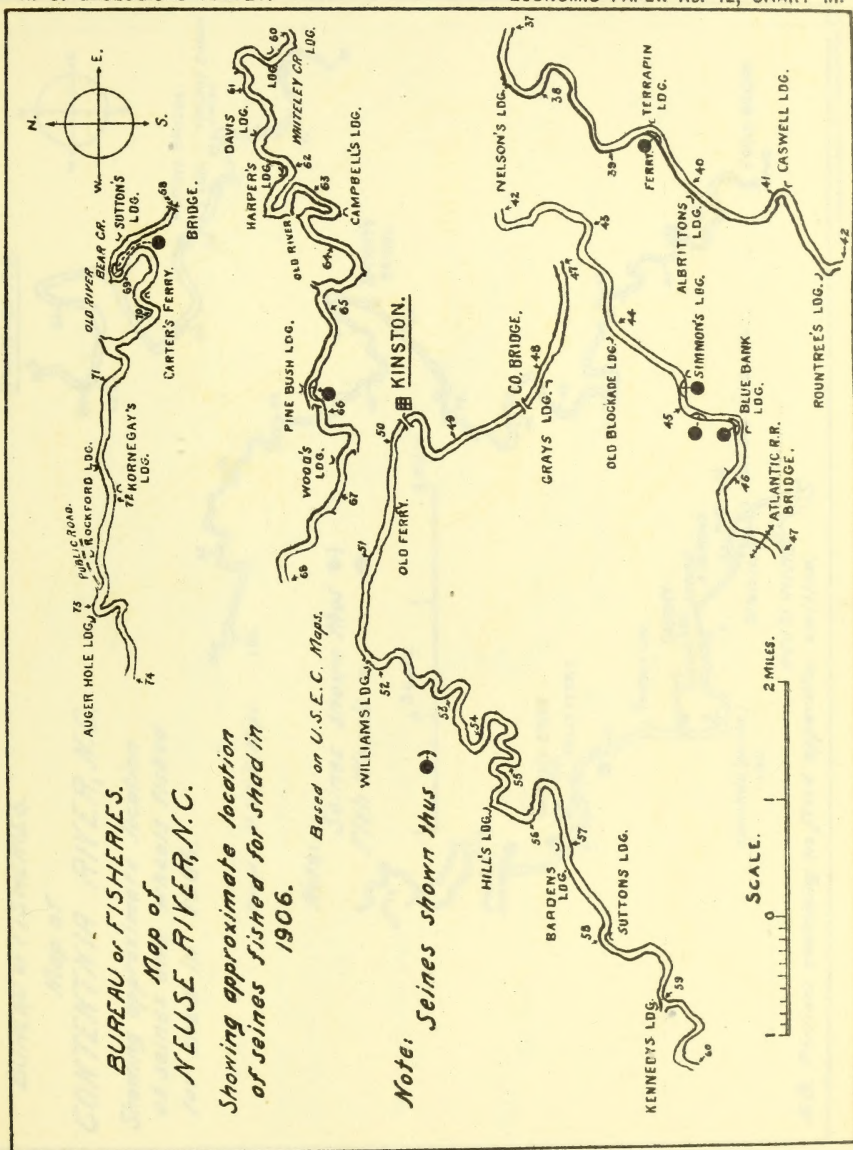


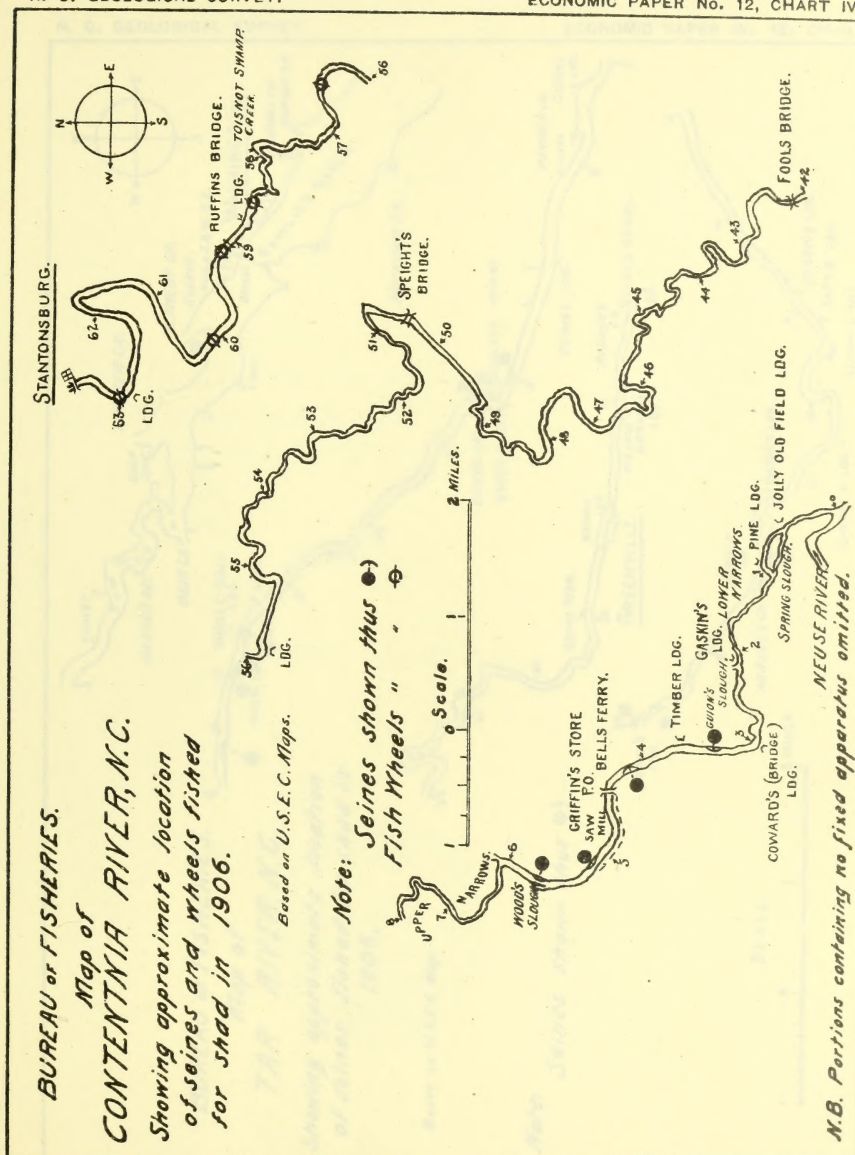


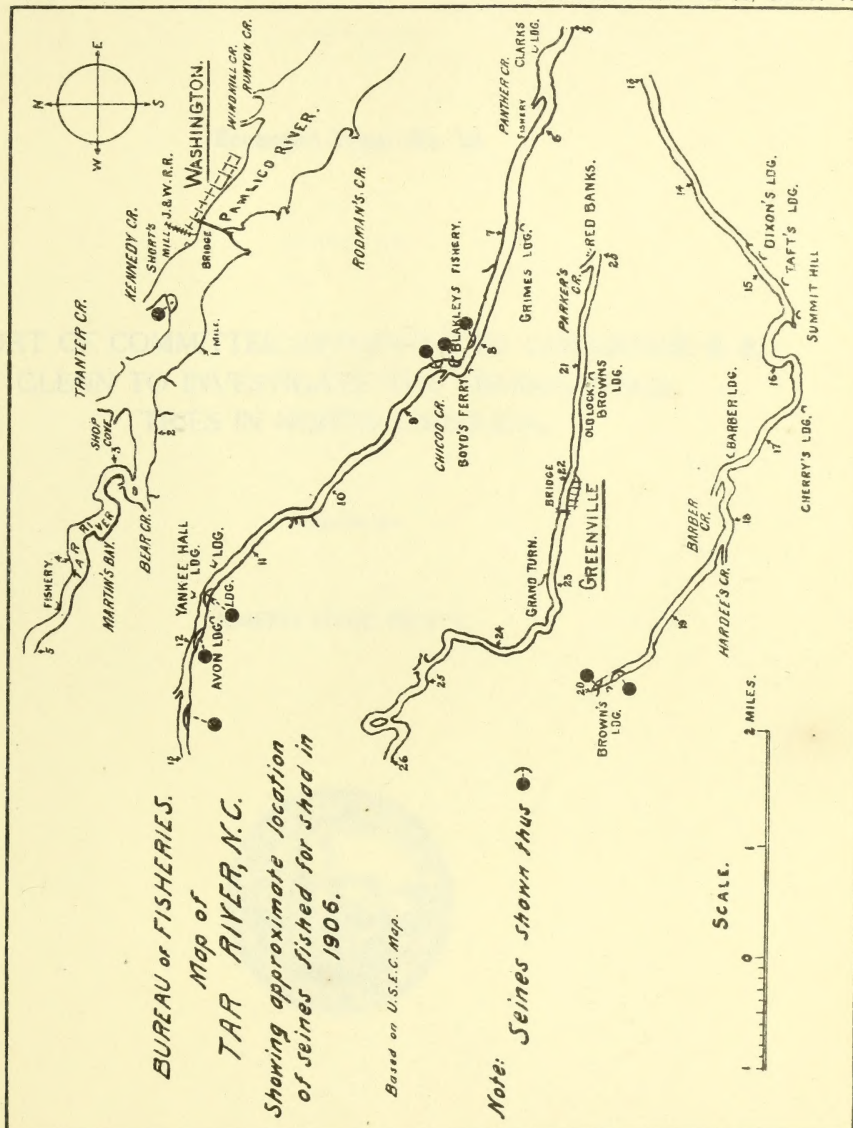
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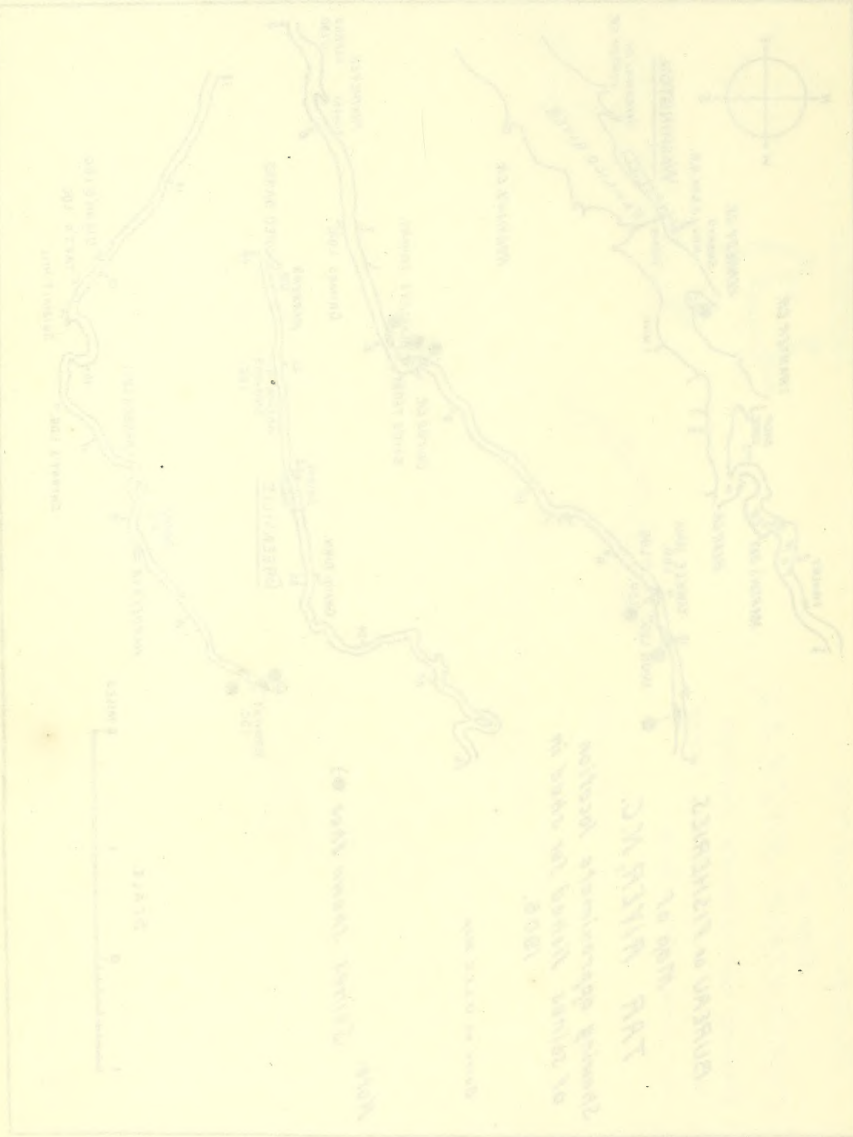


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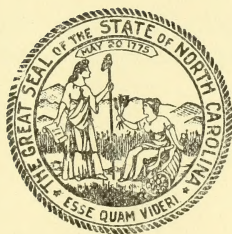
JOSEPH HYDE PRATT, STATE GEOLOGIST.

Economic Paper No. 13.

REPORT OF COMMITTEE APPOINTED BY GOVERNOR R. B. GLENN TO INVESTIGATE THE FISHING INDUS- TRIES IN NORTH CAROLINA.

COMPILED BY

JOSEPH HYDE PRATT.



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LETTER OF TRANSMITTAL.

CHAPEL HILL, N. C., November 15, 1906.

*To his Excellency, HON. R. B. GLENN,
Governor of North Carolina.*

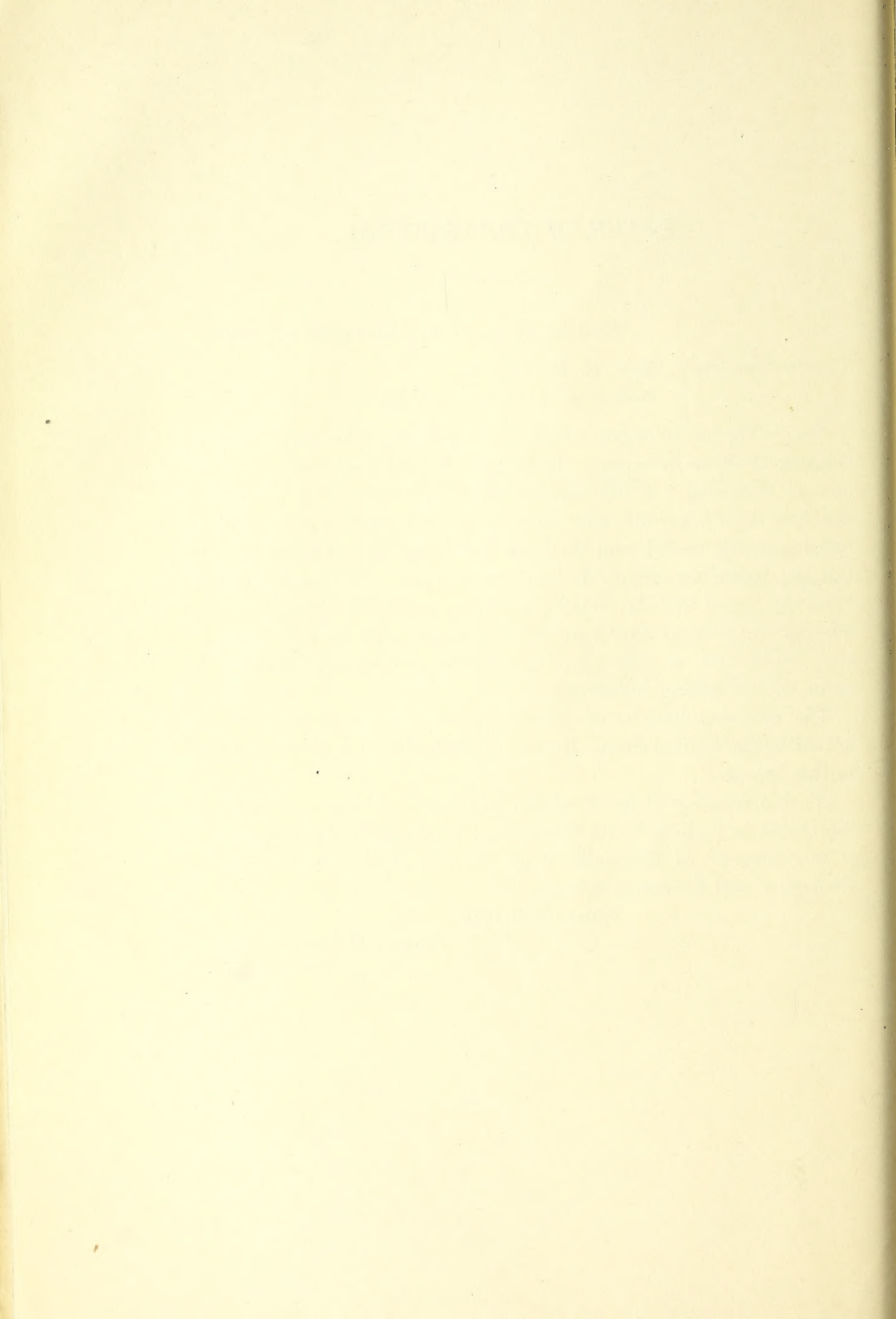
SIR:—The commission which you appointed the latter part of August, 1906, to investigate the fishing industries of North Carolina met at Morehead City the third of September and spent the following five days carefully and thoroughly investigating the problems relating to the fin-fish and shell-fish industries, and respectfully submit the following report of their proceedings. In this report it is earnestly urged that the Legislature make provision for a Fish Commission and a Shell-fish Commission. Suggestions are also made for such legislation as will more thoroughly protect and increase the value of our fishing industries.

The recommendations of your committee are most favorably endorsed by the United States Bureau of Fisheries in a letter appended to this report.

As this report will be of special interest to a large proportion of the people in eastern North Carolina, I respectfully recommend that it be published as Economic Paper No. 13 of the North Carolina Geological and Economic Survey.

Yours obediently,

JOSEPH HYDE PRATT,
State Geologist.



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REPORT OF COMMITTEE ON FISHERIES IN NORTH CAROLINA,

APPOINTED BY

GOVERNOR R. B. GLENN, CHAIRMAN OF GEOLOGICAL AND
ECONOMIC SURVEY BOARD.

The committee appointed by Governor R. B. Glenn, chairman of the Geological and Economic Survey Board, to investigate the fishing industries of the State, met at Morehead City, N. C., on the evening of September 3, 1906, the following being the *personnel* of this committee: J. B. Coffield, of Everetts; J. J. Laughinghouse, of Greenville; T. H. Shepard, of Edenton; W. A. Saunders, of Wilmington; R. W. Smith, of Manteo; W. E. Swindell, of Washington, N. C.; W. O. Lupton, of Belhaven; M. B. Gowdy, of Beaufort; W. M. Webb, of Morehead City; H. F. Moore, of the U. S. Bureau of Fisheries, Washington, D. C.; and Joseph Hyde Pratt, State Geologist, Chapel Hill.

As will be seen from the above, this committee consisted of practical fishermen and oystermen representing all sections of the eastern part of the State where the fisheries are of economic importance, and also of various branches of these industries; as well as of men versed in the scientific side, who were able to give unbiased opinions on all matters under discussion.

The meeting was called to order by Joseph Hyde Pratt, State Geologist, with the following remarks:

"You are asked by his Excellency, Governor R. B. Glenn, to meet together to discuss questions relating to the present condition of the fishing industries in North Carolina, including not only the fin-fish, but also the oyster, clam, terrapin, and all that can be brought under the general head of the fishing industry of North Carolina; and also to suggest some measures that will bring about a change for an improvement in this industry. The first thing in organizing this committee will be the election of a permanent chairman."

Joseph Hyde Pratt, State Geologist, was elected permanent chairman and R. W. Smith, of Manteo, secretary.

In a few words the chairman stated the object of the committee's appointment and the line of work to be taken up.

At this meeting there was a general discussion of the practicability and feasibility of the appointment of a Fish Commission and the question of raising revenue for the support of such a commission. It was the unanimous opinion of those present at this meeting that it is very important and absolutely essential that a Fish Commission be appointed by the Legislature of North Carolina and given such powers as will enable it to enforce all laws relating to the fishing industries of North Carolina. It was also the unanimous opinion that at least a large proportion of the revenue necessary for the support of the Fish Commission should be raised by a direct tax upon every net that is used for fishing in the waters of North Carolina.

Very appropriate remarks were made upon these questions by Messrs. Moore, Smith, Lupton, and the chairman.

It was decided at this meeting that the sessions of the committee should be held both morning and afternoon, and, if necessary, at night.

The meeting adjourned at 10 P. M. until 9 A. M. on Tuesday.

At the regular sessions of the committee all of the questions taken up were very fully and freely discussed by all the members, and in nearly every instance the recommendations of this committee were unanimous. There were certain instances, however, which in most cases related to local questions, where there was a decided difference of opinion between the various members and where on the deciding vote there were one or two against the recommendation as passed. The committee worked hard and conscientiously to make such recommendations as would insure a decided and lasting improvement in the fishing industries of the State and which would result in a large increase in the value of these industries to the State. Each question, as it was taken up, was, as far as possible, discussed before the committee as a whole; but in some instances it was necessary to refer to a subcommittee the drawing up of the detailed suggestions, such as those relating to the Fish Commission, Shell-fish Commission, etc. The work of the subcommittees was in turn referred back to the committee as a whole and passed upon.

It was decided to recommend the organization of a Fish Commission for North Carolina, and suggestions to be incorporated into a bill relating to the formation of the Fish Commission were drawn up and passed unanimously by the committee. These suggestions and

recommendations are given, together with others passed by this committee, at the end of this report. As the committee have recommended so strongly the formation of a Fish Commission and feel confident that the same will be appointed, it did not attempt to recommend many changes in any of the laws that refer to decided local conditions, except where these were known to be injurious to the general fishing industry.

The existing laws relating to the fish and oyster industries as given in the Revisal of 1905 were taken up and carefully discussed; and recommendations made regarding these are given at the end of this report.

These discussions brought out a nearly unanimous opinion that there is over-fishing of the waters of North Carolina, and, as stated by Mr. Moore of the Bureau of Fisheries, "the trouble in the decrease in the quantity of fish in North Carolina comes not from the predominant evils of any particular apparatus, but from the fact that you have caught too many fish; and if you catch them, whether by seines, gill-nets, or pound-nets, you are going to reduce them below the reproductive power of the fishes, and have a reduction in the fisheries. The question of the propagation of fish is one to which the Bureau has given a great deal of attention. Unfortunately, the United States Government can propagate the fish, but has no way of protecting them. Many of the States have neglected to protect their fish; in other words, they have allowed over-fishing. They have allowed apparatus to be used in places where it ought not to be placed, and our efforts have gone for naught. Unless some fish legislation is carried out in North Carolina, there will very likely be some such state of affairs here. To emphasize the point I make, the question is not so much one of particular apparatus as it is one of general over-fishing, and the aim of this Board should be to cut down the amount of apparatus fished and to restrict at all places the fishing season."

Mr. Moore also further stated, in discussing Section 2435: "The amount of apparatus that is fished in the State is obviously considerably greater than the fisheries of the State can support. You have seen the results in a decrease in the catch from year to year. While there is no particular reason that one locality should be permitted to fish nets and another locality be prohibited, at the same time there must be some restriction. I do not know what general

measures the Board will eventually take, but it should take some means to cut down the amount of apparatus that is used, or at least measures that will prevent a very great extension of apparatus over that in use in the past year. Of course, the waters of North Carolina cover a great area and will support a large fishery, but they will not support a fishery that is subject to indefinite extension. Three thousand pound-nets and I don't know how many gill-nets—some million yards, perhaps—compose a great big amount of apparatus to put down in the waters of this State. Now I think that in the attempt to bring about consistency in various matters here, that should be considered.”

Mr. Coffield remarked concerning this section as follows:

“My idea has been, all the while, that the object of the formation of this committee was to suggest some legislation by which the fish might be protected, the catch limited, and the fish interests fostered.”

The result of these discussions of the amount of apparatus and the open season for fishing was a unanimous passage of the following resolutions:

“*Resolved*, That it is the sense of this committee that every endeavor should be used to restrict the amount of apparatus in use for fishing in the tidal waters of North Carolina so that it will not exceed the number nor total length in at the time of the canvass of the United States Bureau of Fisheries in 1906.

“*Resolved*, That the open season for shad, herring, sturgeon, and rockfish should be curtailed as far as possible and the laws regulating same be rigidly enforced.”

The discussion of Section 2440 of the Revisal of 1905, known as the Vann Bill, was very deliberate, and the questions at issue in this bill were very carefully considered and argued by every member of the committee. Mr. R. W. Smith, of Manteo, Roanoke Island, who represented the people most seriously affected by this bill, argued strenuously for more open ground for fishing than first allowed by the Vann Bill. The points raised were discussed pro and con, and the final decision of the committee, which was passed unanimously, is given in the pages following this report under Section 2440. The changes recommended for this bill are such that the committee believe it will really increase the efficiency of the bill in its protection of the shad and herring, and it does at the same time give a larger area

of fishing ground around Roanoke Island and the west shore of Pamlico Sound to the fishermen of Roanoke Island.

A resolution was also passed that, in the event of the formation of a Fish Commission, the Fish Commissioner be requested to investigate the catching of the "run-down" shad and see if provision can not be made so that these can be returned to the water alive.

A subject that was given most serious consideration and discussed in the minutest detail was the cultivation of the oyster and clam in the waters of North Carolina. The result of the deliberations of the committee on this question was the recommendation of legislation which will throw open for cultivation certain definite areas of sea-bottoms in North Carolina and provide an incontestable title to the holders of the bottoms. These recommendations are given at the end of this report under the head of Cultivation of the Oyster. This question was very ably discussed by Messrs. Moore, Lupton, Gowdy, Webb, and the chairman.

Another point taken up of particular importance, especially in the event that the legislation regarding the cultivation of the oyster and clam is passed, was the modification of the laws relating to the Oyster Commissioner. It was the sense of this committee that there should be formed a Shell-fish Commission at whose head would be the Shell-fish Commissioner, who would have the appointment of a Deputy Commissioner and inspectors; and that the organization of this commission should be along similar lines as that of the Fish Commission. Such recommendations for legislation leading to the formation of the Shell-fish Commission are given at the end of this report and represent amendments to Sections 2398, 2403, 2404, 2405, 2406, 2407, and 2422. These recommendations were passed unanimously by the committee, as were also all the recommendations regarding amendments to the present laws.

The work of the oyster inspectors was discussed, and it was brought out quite clearly that their work was not satisfactory. Under the present conditions there is an inspector at every packing-house, which is a heavy burden upon the oyster fund, and especially when the oysters brought in are not thoroughly inspected and the uncultured, according to law, rejected. A remedy has been suggested, as given under Section 2393, which the committee believe will greatly reduce the number of inspectors that will be required to enforce the laws relating to oysters and clams.

The following special resolutions were passed by the committee:

That the State shall exercise exclusive jurisdiction and control over all the shell fisheries of the State, whether these fisheries be for oysters, clams, scallops, or other mollusca.

That the Shell-fish Commissioner shall be given jurisdiction over all the waters of the State as regards oysters, clams, scallops, and other mollusca.

That in case the provisions relating to the cultivation of the oysters presented in this report should fail of passage, no restrictions be proposed in regard to the shipment of shell oysters out of the State.

A motion was made and passed unanimously expressing the appreciation of the committee to Dr. H. F. Moore, of the United States Bureau of Fisheries, for his efficient services, which have been of inestimable value to the committee in their deliberations; and to Dr. R. E. Coker for his interest and assistance in the work of the committee on questions relating to oyster cultivation.

The committee adjourned *sine die*, at noon of Friday, September 9, 1906.

JOSEPH HYDE PRATT,
Chairman.

R. W. SMITH,
Secretary.

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RESOLUTIONS ADOPTED BY THE COMMITTEE INVESTIGATING THE FISHING INDUSTRIES OF THE STATE.

FIN-FISH INDUSTRIES.

In taking up the discussion of the fin-fish industries of North Carolina, it was the unanimous opinion of the committee that in order to protect the fishes of North Carolina and to derive the benefit desired from the laws passed relating to the fin-fish, it is essential and necessary that a Fish Commission be organized and appointed by the Legislature which shall have power to enforce the laws and keep in close touch with the various fishing industries and problems throughout the entire year. The committee unanimously recommend the organization of a Fish Commission according to the following:

1. North Carolina Fish Commission. The Fish Commission shall, except as in this act otherwise provided, consist of a single Commissioner. He shall be appointed by the Governor by and with the advice and consent of the Senate within thirty days after the passage of this act. He shall be responsible for the carrying out of the duties of his office to the Geological and Economic Survey Board and shall make semi-annual reports to them. The term of office of such Commissioner and his successors in office shall be four years, or until their successors are appointed and qualified, and in case of vacancy in the office, the appointment shall be to fill the vacancy. The said Commissioner shall appoint a Deputy Commissioner. During the absence or inability to act of the Commissioner, the Deputy Commissioner shall have and exercise all the powers of the Commissioner. The Commissioner and Deputy Commissioner shall each execute and file with the Secretary of State a bond to the people of the State in the sum of seven thousand and five thousand dollars respectively, with sureties to be approved by the Secretary of State, conditioned for the faithful performance of their duties and to account for and pay over pursuant to law all moneys received by them in their office. The Fish Commissioner shall take and subscribe an oath to support the Constitution and for the faithful performance of the duties of his office, which oath shall be filed with the bond. The Deputy Commissioner may be removed for cause by the Commissioner, who may appoint his successor.

Inspectors or deputies. The Fish Commissioner shall appoint inspectors (or deputies) in each county of the affected territory, who will assist him at whatever time he may need their services. The said inspector may be the Sheriff or his deputy in said county and shall serve under the direction of the Commissioner, receiving compensation not to exceed three dollars per day and necessary expenses while in actual service.

Office and clerical force. The Fish Commissioner shall have an office in some town conveniently located to the maritime fisheries, and he is authorized to employ such clerks as may be necessary for the proper carrying on of the work of his office.

Equipment. The Fish Commissioner is authorized by and with the consent of the Geological and Economic Survey Board to purchase or rent such boats, nets, and other equipment as may be necessary to enable him and his deputies to carry out the duties of his office, as specified in this act.

Duties. The Fish Commissioner shall have charge of the enforcement of all acts relating to the fish and fisheries of North Carolina, except those relating to oysters, clams, scallops, and other mollusca; he shall collect and compile statistics showing the annual product of the fisheries of the State otherwise than those specified above; of the capital invested and the apparatus employed; he shall prepare and have on file in his office maps based on the charts of the United States Coast and Geodetic Survey of the largest scale published, showing as closely as may be the location of all fixed apparatus employed during each fishing season; he shall have surveyed and marked in a prominent manner those areas of the waters of the State in which the use of any or all fishing appliances are prohibited by law; he shall be responsible for the collection of all license fees, taxes, fines, or other imposts upon fisheries and shall receive all fines imposed for the infraction of the fishery laws, and shall pay same into the State Treasury to the credit of the Fish Commission fund to be drawn upon as directed by the Geological and Economic Survey Board; he shall carry on investigations relating to the migrations and habits of the fish in the waters of the State, and for this purpose he may employ such scientific assistants as may be authorized by the Geological and Economic Survey Board.

Arrests without warrant, when and how made. The Fish Commissioner, Deputy Commissioner, and inspectors shall have power, with or without warrants, to arrest any person violating any of the fishery laws.

Power to take fish. The Fish Commissioner and the United States Bureau of Fisheries may take and cause to be taken for scientific purposes, or for fish culture, any fish or other marine organisms at any time from the waters of North Carolina, any law to the contrary notwithstanding.

Salaries. The salary of the Fish Commissioner shall be fifteen hundred dollars per year and the expenses necessarily incurred by him in the discharge of his duties; that of the Deputy Commissioner shall be nine hundred dollars per year and the expenses necessarily incurred by him in the discharge of his duties. The salaries of clerks and of scientific assistants which may be employed from time to time are to be fixed by the Geological and Economic Survey Board.

No interest in fisheries. The Fish Commissioner, Deputy Commissioner, and inspectors shall not be interested in any fishing industry in North Carolina.

Revenue. All license fees, taxes, fines, or other imposts upon the fisheries or fines imposed for infraction of the fishery laws in whatever manner collected, shall be paid to the State Treasurer to the credit of the Fish Commission fund to be drawn upon as directed by the Geological and Economic Survey Board, and shall constitute the revenue of the Fish Commission.

DISCUSSION OF PRESENT FISHING LAWS.

The present fishing laws as they stand on the statute-book of the Revisal of 1905 were taken up and each one reviewed carefully by the committee, who report their opinion regarding them in the following resolutions:

That section

2424. Croatan marshes. If any person, for the purpose of taking fish, shall between the first day of February and the first day of May, of the same year, use or cause to be used, at or within half a mile of the marshes separating the waters of Croatan and Pamlico sounds, any weir, hedge, net or seine, he shall be guilty of a misdemeanor.

Code, s. 3378; R. C., c. 81, s. 4; 1844, c. 40, s. 3.

remain as it is.

That section

2425. Masonboro and Myrtle Grove sounds. If any person shall use any pyke-nets or set down seines, or place any fish-trap for the purpose of catching fish in the waters of Masonboro and Myrtle Grove sounds in New Hanover County, he shall be guilty of a misdemeanor, and fined not more than fifty dollars or imprisoned not more than twenty days.

Code, s. 3421; 1883, c. 288, ss. 1, 2.

remain as it is.

That section

2427. Lay days for Pamlico River. If any person, from the fifteenth day of February to the tenth day of May of every year, from twelve o'clock meridian of Saturday until sunrise Monday morning of each week, shall fish any seine, set-net, drift-net, or any other net of any name or kind whatever, in the waters of Pamlico or Tar rivers and tributaries, except bow or skim nets, he shall be guilty of a misdemeanor.

Code, s. 3416; 1883, c. 137, s. 3.

be repealed, only two of the committee being opposed to this. Under new legislation, a general law is suggested prohibiting the hauling, raising, shooting of any nets from twelve o'clock midnight of Saturday until twelve o'clock midnight Sunday.

That section

2428. Fishing dutch-nets in Pamlico and Tar rivers. If any person shall set down or fish any dutch, pod, pyke, or pound net, or net of like kind, in the waters of Pamlico or Tar rivers or their tributaries, except in the manner, and in the part, and during the time, which such nets are by law allowed to be fished, he shall be guilty of a misdemeanor, and shall be fined not less than fifty dollars nor more than one hundred dollars, and shall be imprisoned in the county jail not less than thirty and not more than sixty days.

Code, s. 3417; 1903, c. 52.

remain as it is.

That section

2429. Dutch-nets in Pamlico River. It shall be lawful to fish with dutch, pod, pyke, or other pound nets, or nets of like kind, in the waters of Pamlico River below a line beginning on the southern shore of Pamlico River at Maule's Point, and running due north to a point on the northern shore of said river: *Provided*, that no dutch, pod, pyke, or pound net, or other net of like kind, shall extend out in said river more than one-eighth of the distance across said river from the shore, and that none of said dutch, pod, pyke, or pound nets shall be set, placed down, or fished nearer to each other than five hundred yards, measuring up and down the river; nor shall they be placed, set down, or fished within five hundred yards of any seine-beach in actual use for hauling a seine, nor within one mile of the mouth of Bath Creek: *Provided*, no nets of the kind

enumerated in this section, or other nets of like kind, shall be placed down, set, or fished in said rivers between the tenth day of May and the first day of July in any year. Whenever any person shall complain to the Oyster Commissioner or any inspector that dutch, pod, or pyke nets, or other nets of like kind, have been placed down or set in any of the waters of Pamlico River, or in any of its tributaries, contrary to and in violation of this section, said Oyster Commissioner or inspector, or person performing the duties of such, shall at once visit said river, make a complete and full examination of all dutch, pod, or pyke nets, or other nets of like kinds, in said river, and ascertain whether they are placed down, set, or fished in violation of the provisions of this section, and he shall report to the Solicitor of the district in which the offense is committed.

Code, s. 3417; 1903, c. 52.

remain as it is, with the exception that the words "Oyster Commissioner" shall be changed to "Fish Commissioner," provided the Fish Commission act creating the Fish Commissioner is passed by the Legislature; and that "tenth day of May" shall read "first day of May."

That section

2430. Dutch-nets in Currituck Sound. If any firm, company, or corporation shall operate or cause to be operated in the waters of Currituck County, or be interested in (in any manner whatsoever) more than six pound or dutch nets, or use more than one hundred yards of hedging to a net, or set a stand of such nets exceeding eight hundred yards in length from land to the extreme outward end; or if any person shall set any pound or dutch nets to the east of the center of Currituck Sound, except that part from the west point of Mackey's Island north of the Virginia line; or if any person shall leave any landing or anchorage before sunrise for the purpose of fishing in Currituck Sound or tributaries, or shall continue to fish after dark, he shall be guilty of a misdemeanor and be fined not less than twenty-five nor more than fifty dollars. This section shall not prohibit fishing after dark in that part of said sound west of a line beginning at the north point of Bell's Island, thence north not more than one thousand yards from the mainland to the mouth or entrance of Tull's Creek, nor night fishing between the thirty-first day of March and the twentieth day of October five hundred yards from the shore from Martin's Point to Kitty's Hawk Bay.

1905, c. 273, ss. 3-7.

remain as it is.

That section

2431. Shipping or selling fish, Currituck County. If any person shall catch or capture any fish with nets or other appliances in the waters of Currituck County between the thirty-first day of March and the twentieth day of October of each year, or shall sell or ship out of the county or State any fresh fish between said dates; or if any person shall be found with more than twenty-five pounds of fresh-water fish in his possession between the thirty-first day of March and the twentieth day of October of each year—herrings, mullets, shad,

and eels excepted; or if any person shall in said county catch eels for market between the thirtieth day of April and the twentieth day of October following in each year, he shall be guilty of a misdemeanor and be fined not more than fifty dollars and not less than twenty-five dollars. Any citizen may catch not to exceed twenty-five pounds at any time for home consumption, and sell or give not more than ten pounds to any one person in one day.

1905, c. 273, s. 1.

remain as it is.

That section

2432. Game warden's right to search vessels. If any constable, game warden or justice of the peace of Currituck County shall be informed, or have cause to suspect, that either of the two preceding sections are being violated, he is hereby authorized and empowered to examine the contents of any fishing-boat, or packages in transit, and any person or common carrier refusing to exhibit the contents of any fishing-boat or package to such officer shall be guilty of a misdemeanor, and shall be fined not less than twenty-five and not more than fifty dollars.

1905, c. 273, ss. 2, 7.

remain as it is.

That section

2433. Direction of nets in Pamlico Sound. Every net (unless the same be a drag-net and hauled to the shore) which may be used for catching shad in that portion of the waters of Pamlico Sound lying between a line drawn eastwardly from Stumpy Point and Mount Pleasant in Hyde County to a point ten miles south of Hatteras Inlet in said sound, shall be set and fixed in said waters, in a direction from north to south, and shall not be used in any other manner; and any person offending against this section shall, for every offense, forfeit five dollars.

Code, s. 3381; 1889, c. 261; R. C., c. 81, s. 7; 1844, c. 40, s. 6.

be repealed.

That section

2434. In Carteret County. If any person shall catch mullets in the waters of Carteret County with a seine or net having a mesh of less than one and one-eighth inch; or if any person shall in the waters of Carteret County, except in Neuse River, use for the purpose of catching fish, except menhaden or fatbacks, any seine or net more than two hundred and seventy-five yards long; or shall join two or more nets together in said county so that the length thereof shall be more than two hundred and twenty-five yards, he shall be guilty of a misdemeanor and fined not more than fifty dollars or imprisoned not more than thirty days. And any person using a net exceeding the length allowed by this section

shall forfeit said net, one-half thereof to go to the informer, the other half to the school fund.

1895, c. 25; 1903, c. 508.

be amended so that the clause "and fined not more more than fifty dollars and imprisoned not more than thirty days" shall read "and fined not less than fifty dollars nor more than one hundred dollars, or imprisoned not less than thirty nor more than sixty days"; and that "school fund" shall read "Fish Commission fund."

That section

2435. Dutch-nets in Carteret County. If any person shall use or cause to be used any dutch-net, pound-net, or other stationary trap, net, or seine of similar description, by whatever name known, in the waters of Carteret County for the purpose of taking fish therefrom, he shall for each day's use thereof forfeit and pay the sum of fifty dollars. The penalties herein created shall be recovered by a warrant before any justice of the peace in the county of Carteret, and shall be applied to the use of the public schools of said county; and such offender, in addition to the penalties contained in this section, shall be guilty of a misdemeanor and fined not less than one hundred dollars nor more than five hundred dollars, or imprisoned in the county jail not less than six months nor more than twelve months: *Provided*, this section shall not apply to the ordinary set-nets heretofore in use in the waters of said county.

Code, s. 3420; 1883, c. 199.

be amended so as to read, "If any person shall use or cause to be used any dutch-net, pound-net, or other stationary trap, net, or seine of similar description, by whatever name known, in the waters of Carteret County for the purpose of taking fish therefrom, he shall for each day's use thereof forfeit and pay the sum of fifty dollars, excepting from Point of Marsh on south side of Neuse River and running westwardly to Adam's Creek and extending out to a distance of one thousand yards from the shore: *Provided*, that in no case shall the distance the nets extend out into the water be greater than one-eighth of the width of the river: *Provided further*, that the nets shall be one-half mile apart. The penalties herein created * * *" to read the same as original section, except that "applied to the use of the public school fund of said county" shall be changed to read, "applied to Fish Commission fund."

That section

2436. Obstructions in Carteret County. If any person shall obstruct any navigable water or passageway for fish in Carteret County by placing bushes, posts, or any stationary material or fixtures in such a manner as to prevent the free passage of fish, he shall be guilty of a misdemeanor and fined not less than one hundred dollars. Nothing in this section shall be construed to prohibit any

person from using a lawful net or seine in any way or manner except as a stop-net or seine. This section shall not apply to any net that the fish can pass freely by one end.

1903, c. 520.

remain as it is.

That section

2437. Mulletts in Carteret. If any person shall fish for or catch any mullets with any purse-seine or purse-net in any waters within the limits of Carteret County, extending to the extreme limits of the State's jurisdiction in and over such waters, he shall be guilty of a misdemeanor and be fined not less than five hundred dollars or imprisoned not less than one year. For the purposes of this section the following boundaries are hereby declared to be the boundaries to which the waters of said county extend, to-wit: A distance of three nautical miles, measured from the outer beach or shores of Carteret County, out and into the waters of the Atlantic Ocean; and any portions of any water within a distance of three miles from said waters of the Atlantic Ocean to any beach or shore of said county shall be deemed the waters of said county for the purposes of this section.

1903, c. 583; 1905, cc. 274, 508.

remain as it is.

That section

2438. Menhaden fishing. If any person shall catch any menhaden or fatbacks within the waters of the State of North Carolina, to the extreme limits of the State's jurisdiction in and over such waters in any purse-net or purse-seine with a bar of less than one inch and with a mesh of less than two inches, or shall knowingly cook or manufacture for fertilizer any menhaden or fatbacks caught in any net or seine having bars of less than one inch or having meshes of less than two inches, at any place within the State of North Carolina, he shall be guilty of a misdemeanor, and for each and every offense shall be fined not less than five hundred dollars or imprisoned for one year, or both, in the discretion of the Court. For the purposes of this section the following boundaries are hereby declared to be the boundaries to which the waters of the said State extend, to-wit: A distance of three nautical miles, measured from the outer beach or shores of the State of North Carolina, out and into the waters of the Atlantic Ocean; and any portions of any water within a distance of three miles from said waters of the Atlantic Ocean to any beach or shore of said State shall be deemed within the waters of said State for the purposes of this section. This section shall not apply to the counties of Dare, Brunswick, Pender, and New Hanover. Every person found fishing for menhaden or fatbacks within three miles of the shore of any county, except the counties of Brunswick, New Hanover, and Pender, shall be presumed to have violated this section. And all such persons, firms, or corporations shall be subject to all the pains and penalties denounced in this section, and they may be prosecuted in the courts of any

county in this State. All persons aiding and abetting shall be guilty as principals.

1905, cc. 274, 508.

remain as it is.

That section.

2439. Dutch-nets in Albemarle Sound and its tributaries. No person shall set or fish any dutch-net or pound-net in Roanoke River, Cashie or Middle and Eastmost rivers, or within two miles of the mouth of said rivers, or within one mile of the mouth of any other river emptying into Albemarle Sound, of less than two miles in width at its mouth, and any such net set within one mile of the mouth of any other river emptying into said sound shall not extend into the main channel at its mouth. No person shall set or fish with a dutch-net or pod-net within half a mile to the eastward or westward of the outside windlasses or snatch-blocks of any seine-fishery in operation on said sound; and any such net set or fished within one mile of such windlasses or snatch-blocks of any seine-fishery in operation shall run in a due north and south course from the shore, and shall not extend further into the sound from the water's edge than the distance from such windlass or snatch-blocks to the line of such net; and all persons who shall set or fish any such net in said sound shall pull up and remove the stakes used for the same by the first day of June next succeeding the fishing season, and if any person shall set or fish any dutch-net or pod-net in said sound in violation of this section, he shall be guilty of a misdemeanor, and be subject to a penalty of three hundred dollars, to be recovered by any person in the Superior Court of the county in which the offense shall be committed. And the Sheriff of such county shall, when requested, remove any portion of such nets set or fished in violation of this section at the cost of the violator: *Provided*, that dutch-nets may be used in Cashie River two and one-half miles from its mouth, if they do not extend more than one-third the width of said river from the shore, and such nets may be along the sound shore on the Bertie County side between the following points along said shore, to-wit: commencing at the mouth of Cherry Tree Cut branch, Kentrock field and Landing field, and running around the shore to the mouth of Morgan swamp, thence to Rock Spring branch, and that any nets set or fished within that line shall not extend from the shore in any direction a greater distance than four hundred and fifty yards measured at high water, and within this distance of four hundred and fifty yards is to be included the nets, hedges and all parts thereof.

Code, s. 3383; 1889, c. 122; 1891, c. 322; 1895, c. 245; 1899, c. 310; 1899, c. 412.

be amended as follows: In line 13, "in a due north and south course" change to read "at right-angles to the shore"; in line 17, "remove the stakes used for the same by the first day of June next succeeding the fishing season" to read "remove all broken, decayed, and abandoned stakes by the first day of May of each year"; and further in lines 21 to 25, beginning "to be recovered" and ending "of the violator," shall be omitted if the Fish Commission act is passed.

ERRATA.

On page 21, in last paragraph, reference to lines 13, 17, 21 and 25 should read lines 11, 15, 18 and 21 respectively.

That section

2440. Dutch-nets in Pamlico and Albemarle sounds. If any person shall set or fish any net, seine, or appliance of any kind for catching fish at any place within a radius of two and one-half miles either way from Roanoke Marshes lighthouse at a distance more than five hundred yards from the shore of Roanoke Island or the mainland on the western side of Croatan and Pamlico sounds; or shall set or fish any pound or dutch net on the eastern side of Pamlico Sound within ten miles of the Roanoke Marshes lighthouse, except such as shall be fished within five hundred yards of the Roanoke Island or Hog Island shores; or shall set or fish any dutch or pound net on the eastern side of Pamlico Sound more than two thousand yards west of a line running south-southeast from Big Island to Bulkhead or shoal west of Chicamacomico or south of said point more than two thousand yards from the shoals as marked on the United States Government chart made from data obtained to November twenty-second, one thousand nine hundred and four; or shall set or fish any dutch or pound net on the west side of Pamlico Sound in said sound extending into the water more than two thousand yards from the shore of the mainland; or shall set or fish any pound or dutch net in Croatan Sound further from the shore than one-fifth the width of said sound at that point; or shall set or fish any pound or dutch net in the Albemarle Sound more than two thousand yards from the shore of the mainland, or in Chowan River further from shore than one-third the width of said river at place where said nets are fished or set, or within one-fourth mile of any wharf used by a steamer on said river; or shall set or fish any net or appliance of any kind for catching fish within one mile on north or south side of a line five miles long running west from center of New Inlet or Oregon Inlet, or on north or south side of a line five miles long running northwest from center of Hatteras Inlet, he shall be guilty of a misdemeanor and be fined or imprisoned, in the discretion of the Court. The provisions of this section shall apply only to that part of each year beginning January fifteenth and ending May fifteenth. The place of trial for offenses under this section shall be the county opposite where the act was committed. It shall be the duty of the Oyster Commissioner or Assistant Oyster Commissioner, whenever an affidavit is delivered to him stating that the affiant is informed and believes that this section is being violated at any particular place, to go himself or send a deputy to such place, investigate same, and he shall seize and remove all nets or other appliances setting or being used in violation of this section, sell same at public auction and apply proceeds of sale to payment of cost and expenses of such removal, and pay any balance remaining to the school fund of county nearest to where offense is committed.

1905, c. 292.

be amended so as to read as follows:

Dutch and other nets in Pamlico and Albemarle sounds and contiguous waters. If any person shall set or fish any net, seine or appliance of any kind for catching fish at any place within a radius of two and one-half miles either way from Roanoke Marshes lighthouse at a distance more than five hundred yards from the shore of Roanoke Island or the mainland on the western side of Croatan and Pamlico sounds, *except that on the western side of Pamlico and Croatan*

sounds fishing shall be permitted in that territory extending one thousand yards from the shore beginning at the two and one-half mile limit heretofore defined and extending to the southern end of the Roanoke Marshes on the Pamlico Sound side and to the north end of the same marshes on the Croatan side, but in neither case shall the nets within this one-thousand-yard limit be within one and one-quarter miles in any direction from the Roanoke marshes lighthouse; or shall set or fish any pound or dutch net on the eastern side of Pamlico Sound within ten miles of the Roanoke Marshes lighthouse, except such as shall be fished within one thousand yards of the Roanoke Island or Hog Island shores; or shall set or fish any dutch or pound net on the eastern side of Pamlico Sound more than two thousand yards west of a line running south-southeast (*magnetic*) from Big Island to a point on the twelve-foot curve westerly of Chicamacomico, or south of said point more than two thousand yards from the twelve-foot curve as marked on the chart of the Coast and Geodetic Survey corrected from data obtained to November 22, 1904; or shall set or fish any dutch or pound net on the west side of Pamlico Sound in said sound extending into the water more than two thousand yards from the shore of the mainland; or shall set or fish any pound or dutch net in Croatan Sound further from the shore than one-fifth of the width of said sound at that point; or shall set or fish any net, seine, or appliance of any kind for catching fish at any place within the area of one-fifth the width of the sound or river on either side of a line passing through the middle of Croatan and Albemarle sounds up Chowan River and other tributaries of Albemarle Sound; or shall set or fish any pound or dutch net in the Albemarle Sound more than two thousand yards from the shore of the mainland or in Chowan River further from the shore than one-fourth of the width of said river at the place where said nets are fished or set or within one-fourth mile of any wharf used by a steamer on said river; or shall set or fish any net or appliance of any kind for catching fish within one mile on either side of a line running westerly or southwesterly from the center of New Inlet to an intersection with the line extending from Big Island southeast (*magnetic*) or within one mile on either side of a line running westerly or southwesterly from the center of Oregon Inlet to a point two thousand yards west of the continuation of the said line running from Big Island south-southeast (*magnetic*) or within one mile on either side of a line six miles long

running from the center of Hatteras Inlet through and beyond Hatteras Inlet lighthouse, these restricted areas to include the channels extending from Oregon, New, and Hatteras inlets respectively, he shall be guilty of a misdemeanor and be fined not less than fifty (50) dollars or imprisoned not less than thirty days, in the discretion of the Court. The provisions of this section shall apply only to that part of each year in which shad and herring fishing are permitted by law in the several waters. The place of trial for offenses under this section shall be the county opposite where the act was committed.

That section

2441. Perquimans River. If any person shall fish with any seine, or set any dutch-net or hedge within one mile of a straight line commencing at Stephenson's Point or the north side of Perquimans River and running in a southwesterly direction to the nearest point of land on the south side of said river known as Belgrade Bluff, or shall haul any seine or set any dutch-net or other kind of net so as to extend beyond the middle of said river at any point thereof, he shall be guilty of a misdemeanor.

1893, c. 147, ss. 1, 2, 4.

remain as it is.

That section

2442. Pasquotank County. If any person shall set any pyke or pound net in Pasquotank River above the town of Elizabeth City, or shall haul or fish with a drag-net, or set a pound-net in Big Hatley Creek, or Little Hatley Creek, within two hundred yards of the mouth of either of said creeks, he shall be guilty of a misdemeanor and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1895, c. 389; 1903, c. 497.

remain as it is.

That section

2443. Obstructions in Little River. If any person shall place any obstruction in Little River, dividing the counties of Pasquotank and Perquimans, and allow it to remain for a longer time than ten days, he shall be guilty of a misdemeanor, and fined not less than five dollars nor more than ten dollars: *Provided*, nothing in this section shall be so construed as to prohibit citizens from fishing with dip-nets in said river during the months of March and April in each year.

Code, s. 3400; 1881, c. 18.

remain as it is.

That section

2444. Fish offal not thrown in navigable waters. If any person shall throw, or cause to be thrown, into the channel of any of the navigable waters of the

State, any fish offal, in any quantity that shall be likely to hinder or prevent the passage of fish along such channel, or if any person shall throw or cause to be thrown into the waters known as the Frying Pan, tributary to the Great Alligator River in Tyrrell County, any fish offal in any quantities whatsoever, he shall be guilty of a misdemeanor.

Code, ss. 3386, 3389, 3407.

remain as it is.

That section

2445. Scuppernong River. If any person shall set any kind of a fish weir or pod-net, gill-net, or net of any kind in the Scuppernong River using more than one-half of the channel of said river, or within one hundred yards of the public bridges at Columbia and the Cross landing, crossing said river, he shall be guilty of a misdemeanor, and fined a sum not to exceed fifty dollars, or imprisoned not to exceed thirty days: *Provided*, this section shall not apply to the hauling of seines.

Code, s. 3408; 1885, c. 18; 1903, c. 91.

remain as it is.

That section

2446. Drift-nets in the sounds. If any person shall drift or fish any drift-nets between the first day of February and the first day of May of any year, within two miles of the mouth of any river emptying into Albemarle Sound, or within three miles of any seine-beach on the Albemarle or Croatan sounds while being fished, or within ten miles of Ocracoke, Hatteras, Oregon, or New inlets, or within ten miles of the Roanoke Marshes, he shall be guilty of a misdemeanor, and be fined not less than fifty dollars or imprisoned not less than thirty days: *Provided*, the people of Dare County shall be allowed to use drift-nets for herring.

Code, s. 3396; 1881, c. 274, ss. 1, 2; 1883, c. 145.

remain as it is.

That section

2447. Frying Pan Creek, Tyrrell County. If any person shall fish any pound-net, gill-net, seine, or nets of any kind in Alligator River within one mile of the mouth of Frying Pan Creek in Tyrrell County, or shall set any weir or fish net of any kind or any other obstruction that prevents the passage of fish in said creek from its mouth to Jarmin's Point, at the two pines and low cypress, he shall be guilty of a misdemeanor.

1889, c. 105; 1899, c. 465.

remain as it is.

That section

2448. Net stakes removed from certain waters. Every person who shall set or use any net in the waters of Pamlico, Croatan, Currituck, or Albemarle sounds, or their tributaries, except Perquimans River, shall be required to pull

up and remove their net-stakes within thirty days from the day the nets were taken from them, and not later than the first day of June, and any person failing to pull up and remove their stakes, as required by this section, shall be guilty of a misdemeanor, and fined not more than fifty dollars or imprisoned not more than thirty days.

Code, ss. 3382, 3414; 1883, c. 69; R. C., c. 81, s. 8; 1844, c. 40, s. 7; 1852, c. 13; 1893, c. 147.

be amended as follows: "and remove their net-stakes within thirty days from the day the nets were taken from them, and not later than the first day of June," to read "and remove all broken, decayed, and abandoned stakes by the first day of May of each year."

That section

2449. Fishing in Frying Pan, Tyrrell County. If any person shall set any pound-net or dutch-net in Alligator River within one-half mile of the mouth of Frying Pan Creek in Tyrrell County, or in Frying Pan Creek within three miles of where it enters into Alligator River, he shall be guilty of a misdemeanor and shall be fined fifty dollars or imprisoned thirty days, or both, at the discretion of the Court.

1905, c. 282.

remain as it is.

That section

2450. Dutch-nets at the inlets. If any person shall set any pound-net, dutch-net, or hedge-net within two miles of Oregon Inlet or Hatteras Inlet or within ten miles of New Inlet in Dare County, North Carolina, or shall between the first day of January and the first day of May following of any year, set or operate any seine or stationary nets of any kind in the main channels within three miles of the inside mouths of Ocracoke, Hatteras, Oregon, or any other inlet north of Ocracoke Inlet, connecting the waters of the Atlantic Ocean with any of the sounds or other inland waters of North Carolina, or shall fish with seines or nets of any description in the waters of Bear Inlet or Brown's Inlet or within one mile of Bear Inlet or Brown's Inlet, on the eastern or western beach of said inlets, except at regularly established fisheries on said Bear or Brown's Inlet beaches, or shall fish with seines or nets on the inside of said Bear or Brown's Inlet within one-fourth mile of said inlets between the first day of October and the first day of April, he shall be guilty of a misdemeanor.

1893, c. 216; 1903, c. 724; 1903, c. 416.

be amended so that the reference to New Inlet, Hatteras Inlet, and Oregon Inlet be omitted to conform with the revision of Section 2440.

That section

2451. Anchor-nets in Albemarle Sound. If any person shall set or fish an anchor, drift, or staked gill-net in the waters of Albemarle Sound or its tributaries west of a line running from Skinner's Point buoy to Roanoke lighthouse, or if any person shall, east of said line, set or fish in the waters of said sound

or its tributaries any anchor, drift, or staked gill-net longer than one thousand yards, or combination of such nets longer than one thousand yards; or shall set or fish any anchor, drift, or staked gill-nets within one and one-half miles of any seine-grounds on the said sound or rivers emptying therein or within one-half mile of any dutch-net stand where the same is now located in said sound or rivers, unless said seine-ground or dutch-net stand is owned by the person setting such nets; or shall set or fish any line or row of anchor, drift, or staked gill-nets anywhere in said sound or rivers nearer to any other row of such nets than half the length of the longer of said row, he shall be guilty of a misdemeanor, and shall be fined not exceeding one hundred dollars or be imprisoned not more than thirty days. And any person who shall wilfully violate the provisions of this section shall forfeit and pay for each violation of the same the sum of one hundred dollars, to be recovered in a civil action by any one who will sue therefor; one-half of said recovery shall inure to the benefit of the public school fund.

1897, c. 51; 1899, c. 41; 1899, c. 130.

remain as it is.

That section

2452. Pamlico County. If any person shall set or fish any dutch or pound nets in the waters of Pamlico County, or shall use any seine or drag-net in the waters of said county, including the north side of Neuse River from the mouth of the river to the mouth of upper Broad Creek, from the first day of May to the first day of January next ensuing, or shall at any time catch fish with a seine or drag-net along the shores of said county on any day of the week except Monday, Wednesday, and Friday, he shall be guilty of a misdemeanor, and be fined not more than fifty dollars or imprisoned not more than thirty days.

1885, c. 198; 1889, c. 544; 1893, c. 334.

be repealed.

That section

2453. Dutch-nets in Neuse River. If any person shall use or cause to be used any dutch-net, pound-net, or other stationary trap-net, or seine of similar description, by whatever name known, in the waters of Neuse River for the purpose of taking fish therefrom, except the ordinary set-net in use in said river, prior to the first day of January, one thousand eight hundred and ninety-seven, he shall for each day's use thereof as aforesaid forfeit and pay the sum of fifty dollars. The penalties herein created shall be recovered by warrant before any justice of the peace in the county of Carteret, Craven, and Pamlico or Lenoir, and shall be applied to the use of the public schools of said counties, and such offender in addition to the penalties contained in this section shall be guilty of a misdemeanor and shall be fined not less than one hundred dollars, nor more than five hundred dollars, or imprisoned in the county jail not less than six months nor more than twelve months: *Provided*, that a resident and citizen of the State may fish with dutch, trap, or pound nets in the waters of Neuse River on the Pamlico side of said river between the mouth of said river and Upper Broad Creek not more than five hundred yards from the shore.

Code, s. 3397; 1897, c. 145; 1899, c. 299; 1899, c. 422; 1899, c. 435; 1901, c. 74; 1903, c. 704; 1905, c. 817.

remain as it is, except that fine shall be paid to Fish Commission fund.

That section

2454. Size of meshes for seines in Neuse and Trent rivers. If any person shall use any drag-net or seine with bars of less size than one and a quarter inches in the Neuse and Trent rivers, or in any of the tributaries thereof, except for the purpose of catching herring, from the fifteenth day of January to the fifteenth day of May of each year, he shall be guilty of a misdemeanor, and fined not less than five nor more than fifty dollars for every offense. This section shall not apply to the waters of the Neuse and its tributaries above the Wayne and Johnston county lines.

Code, s. 3395; 1881, c. 146, ss. 1, 2.

remain as it is.

That section

2455. Fishing in Trent River. If any person shall set any trap, dutch, pound, or pod net of any description whatever in Trent River, or shall at any time extend his set-nets more than one-third the distance across the Trent River from either side, or shall set any net nearer to any other net than one hundred yards either on the same or on the opposite side of the river, or shall fish with seines or set-nets of any description in Trent River from its mouth to upper Tucker bridge, between the hours of twelve o'clock noon on Saturday and twelve o'clock noon on Monday of each week, or shall set or haul a net or seine of any description between the town of Trenton and Brown's mill on said river from the sixteenth day of May to the first day of August in each year, he shall be guilty of a misdemeanor, and shall be fined not less than five dollars nor more than ten dollars, or be imprisoned not less than ten nor more than thirty days.

Code, s. 3397; 1893, c. 447; 1897, c. 294.

be amended so that in next to the last line "not less than five dollars nor more than ten dollars" shall read "not less than fifty dollars nor more than one hundred dollars."

That section

2456. Fishing or shooting on bridges across Neuse or Trent River at New Bern. If any person being upon the bridges or either of them which span the Neuse and Trent rivers at the city of New Bern, shall fish in the waters of said rivers while being on said bridges, except with hand-line not attached to any pole, or shall use fire or shoot any firearms while standing or being upon either of said bridges, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1901, c. 36; 1901, c. 326; 1903, c. 71.

remain as it is.

That section

2457. Setting nets across streams. If any person shall set a net of any description across the main channel of any river or creek, or shall erect, so as to extend more than three-fourths of the distance, across any such river or creek

any stand, dam, weir, hedge, or other obstruction to the passage of fish, or shall erect any stand, dam, weir, or hedge in any part of any river or creek that may be left open for the passage of fish, or who, having erected any dam where the same was allowed, and shall not make and keep open such slope or fishway as may be required by law to be kept open for the free passage of fish, he shall be guilty of a misdemeanor.

Code, ss. 3387, 3388, 3389.

remain as it is.

That section

2458. Hauling seines, Cherokee County. If any person shall fish with seines or drag-nets or place any finger or fall traps in the Valley River, Notla and Hiawassee rivers in the county of Cherokee, for the purpose of catching fish from said rivers, from the fifteenth of March to the first day of June in each year, he shall be guilty of a misdemeanor, and fined not less than ten nor more than fifty dollars, or imprisoned not less than ten nor more than thirty days.

Code, s. 3399; 1881, c. 12; 1897, c. 293.

remain as it is.

That section

2459. License tax on non-residents fishing with seines. If any person, not being a citizen and resident of this State, shall catch fish by seines, nets, or other appliances for taking fish for marketable purposes in any waters within the jurisdiction of this State, without first obtaining therefor a license from the State Treasurer and for which he shall pay a privilege tax of twenty-five hundred dollars per annum, he shall be guilty of a misdemeanor, and upon conviction in the Superior Court of any county contiguous to the waters so fished as aforesaid, shall be fined not exceeding three thousand dollars or imprisoned not exceeding two years, or be both fined and imprisoned, as aforesaid, in the discretion of the Court; and any citizen of this State, or other person who shall form an alliance or copartnership with a non-resident for the purpose of evading this section or who shall act as an agent of any such non-resident, or as his servant, agent, or employee, shall be deemed guilty of a misdemeanor, and upon conviction in the Superior Court of any county bordering upon the waters fished as aforesaid, shall be fined not less than one hundred dollars or imprisoned not less than six months, or both, in the discretion of the Court; and the nets, seines, boats, or other appliances of such person shall be liable by civil action to seizure and confiscation for the benefit of the public school fund. Any person who shall violate this section shall forfeit and pay the sum of five hundred dollars for each day engaged in fishing as aforesaid, to be sued for and recovered by any citizen of this State, the one-half of such recovery to be to the use of such citizen so suing and recovering the same, and the other half to the school fund. In any civil action for the recovery of the penalties hereinbefore provided for and mentioned, no person, agent, servant, or other employee shall be excused from testifying therein on the ground of incriminating himself by his answer, but such

answer shall not be used as evidence against such witness so testifying in any criminal action whatsoever.

Code, s. 2202; 1897, c. 35; 1899, c. 52.

remain as it is, except that "public school fund" be changed to read "Fish Commission fund."

That section

2460. Right to fisheries. Whenever any person shall acquire title to lands covered by navigable water under the chapter entitled Grants, the owner or person so acquiring title shall have the right to establish fisheries upon said lands; and whenever the owners of such lands shall improve the same by clearing off and cutting therefrom logs, roots, stumps, or other obstructions, so that the said land may be used for the purpose of drawing or hauling nets or seines thereon for the purpose of taking or catching fish, then and in that case the person who makes or causes to be made the said improvements, his heirs and assigns, shall have prior right to the use of the land so improved, in drawing, hauling, drifting, or setting nets or seines thereon, and it shall be unlawful for any person, without the consent of such owner, to draw or haul nets or seines upon the land so improved by the owner thereof for the purpose of drawing or hauling nets or seines thereon; and this section shall apply where the owner of such lands shall erect platforms or structures of any kind thereon to be used in fishing with nets and seines; and every person who shall wilfully destroy or injure the said platform or structures, or shall interfere with or molest the owner in the use of such lands as aforesaid, or in any other manner shall violate this section, shall be guilty of a misdemeanor: *Provided*, this section shall not be so construed as to relieve any person from punishment for the obstruction of navigation.

Code, s. 3384; 1874-5, c. 183, ss. 1-6.

remain as it is.

That section

2461. Obstruction of fish in Hiawassee River. No person shall make, construct, or build any dam, drag-net, or seine across more than three-fourths of Hiawassee River, so as to prevent or hinder the free passage of fish in said river, and any person making or using any dam, drag-net, or seine in said river shall leave open and unobstructed to the free passage of fish at least one-fourth of said river, in width, on the side most favorable to the passage of fish. Any person offending against this section shall be guilty of a misdemeanor, and fined not more than ten dollars for each twenty-four hours said river is so obstructed, one-half to the use of the school fund, the other to the use of the county in which such violation occurs.

Code, s. 3398; 1881, c. 11, ss. 1, 2, 3.

remain as it is.

That section

2462. Regulated in certain streams. No person shall place or allow to remain any dam for mill or factory purposes in the Chowan River between Holli-

day's Island and the Virginia line; in the Meherrin River between its mouth and the Virginia line; in the Roanoke River from the mouth of the Cashie River to the Virginia line; in the Dan River from the crossing of the State line to a point nearest Danbury; in the Neuse River from New Bern to Neuse station in Wake County; in Contentnea Creek from its junction with the Neuse to the junction of Turkey and Moccasin creeks; in the Cape Fear River from Wilmington to the junction of Haw and Deep rivers, and thence in Haw River to the line of Chatham and Alamance counties, and also in Deep River to the Randolph and Chatham line; in Rocky River from its mouth to the crossing of the Pittsboro and Ashboro road; in the New Hope River from its mouth to the Orange County line; in Northeast Cape Fear River from Wilmington to South Washington; in Black River from its mouth to the junction of the Coharie; in the South River from its junction with the Black River to the crossings of the Fayetteville and Warsaw public road; in Lumber River from the State line to the northern boundary of Robeson County; in the Yadkin River from the State line to Patterson's factory; in Elk Creek, a tributary of the Yadkin River, from its mouth to Daniel Wheeler's in Watauga County; in Stony Fork Creek, a tributary of the Yadkin River, from its mouth to John Jones' old store; in Ararat River from its mouth to the bridge at Mount Airy; in Linville River from its mouth to Linville Falls; in North Fork of Catawba from its mouth to Turkey Cove; in Broad River from the State line to Reedy Patch Creek; in Greene River from its mouth to its junction with North Pacolet; in the Tennessee River from the State line to its junction with the Nantahala; in Pigeon River from the State line to the Forks of Pigeon; in the French Broad River from the State line to Brevard, and in the Swannanoa River; in Toe River from the State line to the confluence of the North and South Forks of Toe; in New River from the State line to the point of divergence from the western boundary-line of Alleghany County; in Little River in Johnston County from its junction with Neuse River in Wayne County to the Wake County line; in Cain River from the mouth of same to mouth of Bolling Creek in Yancey County, also Old Fields of Toe on North Toe River in Mitchell County; Johns River from its mouth to the forks of said river near Carrell Moore's in Caldwell County; Catawba River from the South Carolina line to the town of Old Fort in McDowell County, unless the owner thereof shall construct thereon at his own expense a sluice-way for the free passage of fish, of a width not less than three feet nor more than ten: *Provided*, such sluice-way shall be constructed according to plans and specifications to be furnished by the Board of Agriculture, and shall not injure the water-power of such owner: *Provided further*, in order to ascertain whether sluice-ways will or will not injure the water-power aforesaid, the owner of such dam may select two disinterested persons and the Board of Agriculture two others, who may select the fifth person to aid in the arbitration and settlement of such complaint: *Provided further*, this section shall not apply to Pigeon River in Haywood County: *Provided, also*, it shall be lawful for any person to remove any obstruction in the main channel of the Cape Fear River to the width of one hundred feet, for the free passage of fish in the county of Harnett. This proviso, however, shall not apply to any dam or obstruction placed or kept upon said river by the Cape Fear Iron and Steel Company.

Code, s. 3410; 1901, c. 208; 1880, c. 34; 1881, cc. 21, 32, 250, 320; 1905, c. 278.

remain as it is, except that "Board of Agriculture" shall read "Fish Commission."

That sections

2463. Sluice-ways kept open when constructed. The sluice-ways referred to in the preceding section shall be so constructed and placed upon such dams by the owner thereof within sixty days after notice has been given by the Board of Agriculture, under a penalty of one hundred dollars per day for each day thereafter that such dam shall remain without such sluice-way, and shall be kept open by him during the months of February, March, April, May, June, October, and November, and at all other times when there is sufficient water to supply both the water-power and the sluice-way, a fine of fifty dollars per day for each day said sluice-way shall be allowed to remain closed, and any person who shall fish with net, trap, hook and line, or who shall take in any way whatsoever any fish within two hundred feet of said sluice-way shall be subject to a fine of one dollar for each fish so taken, or a fine of fifty dollars for each offense, or imprisonment for thirty days.

Code, s. 3411; 1880, c. 34, s. 2.

and

2464. Obstructions removed. No other obstruction to the passage of fish shall exist or be built between the designated points in the streams mentioned in the two preceding sections unless an opening of not less than twenty-five feet, and not more than seventy-five feet, embracing the main channel of said streams, shall be made by the owner of such obstructions within twenty days after notice from the Board of Agriculture to make such opening under penalty of fifty dollars per day for each day such obstruction shall remain unopened. Said notice shall be served by the Sheriff of the county, and his return shall be *prima facie* evidence of notice in any suit for such penalty.

Code, s. 3412; 1880, c. 34, s. 3.

remain as they are, except that "Board of Agriculture" shall read "Fish Commission."

That section

2465. Vessel injuring nets. If any master or other person having the management or control of a vessel or boat of any kind, in the navigable waters of the State, shall wilfully, wantonly, and unnecessarily do injury to any seine or net, which may be lawfully hauled, set, or fixed in said waters for the purpose of taking fish, he shall forfeit and pay to the owner of such seine or net, or other person injured by such act, one hundred dollars, and shall be guilty of a misdemeanor.

Code, ss. 3385, 3389.

remain as it is.

That section

2466. Use of dynamite for killing fish. If any person shall use any dynamite or any other explosive agent whatever for killing fish, or shall explode any dynamite or other explosive agent in the public waters of the State where fish

are found, except for mechanical or manufacturing purposes, he shall be guilty of a misdemeanor and fined not more than fifty dollars or imprisoned not more than thirty days. The possession of fish killed by explosive agencies shall be *prima facie* evidence that explosives were used for the purpose of killing fish.

Code, s. 3405; 1889, c. 312.

remain as it is.

That section

2467. When non-resident may use seines. If any person who has not resided in the State continuously for at least twelve months next preceding the day on which he shall begin to take fish shall use, or cause to be used, in any of the waters of the State, any weir, hedge, net, or seine, for the purpose of taking fish for sale or exportation, or if any person shall assist in using, or be interested in using or causing to be used, in any such waters for the purpose aforesaid, any weir, hedge, net, seine, or tongs in the use of which any such non-resident person may have an interest, he shall be guilty of a misdemeanor. Nothing herein shall prevent any person from fishing with seines hauled to the shore at any fishery, the title to which fishery or any interest therein having been acquired by such person by purchase or inheritance. This section shall not extend to servants employed to fish by any persons allowed to fish in the navigable waters of the State: *Provided*, no non-resident of the State shall make any sale, assignment, or transfer of any fishery, weir, or other fishing apparatus, or privilege mentioned in this section, to any citizen of the State for the purpose of operating and working said fishery, weir, or other fishing apparatus as aforesaid, under the name and ownership of such citizen, or as the servant or employee of any citizen; and any sale, transfer, or assignment not made *bona fide* and for a full consideration shall be null and void. Upon affidavit founded upon information and belief that any non-resident of the State is operating any such fishery, weir, or other fishing apparatus as aforesaid in the waters of the State, under such sale, assignment, or transfer, as the pretended servant or employee of any citizen of the State, it shall be the duty of the justice of the peace before whom said affidavit is made to issue a warrant against the said non-resident and citizen under whose name said fishery is operated, and upon conviction the said offenders shall be guilty of a misdemeanor, and shall, for every offense, be fined not more than fifty dollars, or imprisoned not more than thirty days. Upon the said trial the burden of proof shall be on the defendants to prove the *bona fides* and full consideration of said sale or transfer.

Code, ss. 3379, 3380; R. C., c. 81, s. 5; 1844, c. 40, s. 1; 1876-7, c. 33; 1883, c. 171.

remain as it is.

That section

2468. In New Hanover County. If any person shall use any net for catching sturgeon in the waters of New Hanover County, the bars of the meshes of which net shall be less than ten inches in the diamond; or if any person shall fish any seine or net in the waters of said county between the first day of January and the first day of July of each year, or shall haul a seine or nets or pod fish within

three hundred yards of any established fishery, except with the nets of such fishery; or shall set or fish any stationary nets in the waters of the Cape Fear River, except on the east side thereof and in New Hanover County; or shall set any net in said river otherwise than east or west, or shall own or control more than one line of nets, or shall operate or fish any shad-nets in Cape Fear River below the mouth of Brunswick River between the fifteenth day of April and the first day of January of any year; or shall set any set-net or stationary net of any kind in the Cape Fear River north of the mouth of the Brunswick River, or in the Brunswick River; or shall operate any drift-net in the Cape Fear River of more than three hundred yards in length, or shall catch shad in said river with seines or nets from the fifteenth of May to the first of January, he shall be guilty of a misdemeanor. The possession of a sturgeon-net with meshes of a size smaller than allowed by this section shall be *prima facie* evidence of having fished the same. In setting nets in Cape Fear River as allowed by this section the following rules shall prevail: They shall begin at a point one hundred yards from the edge of the channel on the east side of said river and running thence due east one hundred and twenty yards, then leaving a gap of one hundred and twenty yards. Then from the east end of said gap another net may be set one hundred and twenty yards only, and to continue in the same proportion, always requiring a gap of one hundred and twenty yards to intervene between each one hundred and twenty yards of nets so set, and no net or sets of nets of any kind shall be placed opposite said gaps, within a distance of a half mile of same, and none of the nets so set shall be nearer than a half mile of the west shore of said Cape Fear River. An established fishery in the meaning of this section is one where there is a camp for the use of the hands, and where the seine or nets and boats used by the said fishery are kept, and where the said fishery was established prior to the first day of January, one thousand eight hundred and ninety-nine.

Code, s. 3403; 1901, c. 173; 1899, c. 440; 1881, c. 280.

remain as it is.

That section

2469. Northeast Cape Fear. If any person shall fish in the northeast branch of the Cape Fear River with seine, net, or trap, from the twenty-third day of February to the first day of July of any year, between the hours of six o'clock P. M. on Saturday and six o'clock P. M. on Monday of each week, or shall at any time use more than one seine at a time in any fishing-hole in said river, or use, set, or place in said river any hedge, trap, or other obstruction which will prevent the free passage of fish up said river, which said hedge, trap, or other obstruction shall extend more than one-third across the main channel of the said river, he shall be guilty of a misdemeanor. This section shall not apply to that portion of said river which lies between the city of Wilmington and a point on said river known as The Three Cypresses, twelve miles distant from said city of Wilmington.

1889, c. 182; 1891, c. 198.

remain as it is.

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That section

2470. In Brunswick, New Hanover, and Pender counties. If any person shall use in any of the waters of Brunswick, New Hanover, and Pender counties any nets, seines, set-downs, fish-traps, or any other nets of any description, for the purpose of taking fish, the bars of the meshes of which nets, seines, set-downs, or fish-traps shall be less than one and one-eighth inches in length; or shall, with seines or nets of any kind, catch any fish in the waters of the Cape Fear River from its mouth to the Bladen County line, or in the waters of the Northeast Cape Fear or Black rivers in Pender County between six o'clock P. M. on Tuesday and six o'clock P. M. on Wednesday, or shall obstruct the free passage of fish in the waters of said rivers, he shall be guilty of a misdemeanor.

1885, c. 226; 1887, c. 71.

remain as it is.

That section

2471. In Black River and Mingo Creek. If any person shall fish in that part of Black River in Sampson and Cumberland counties and below the Atlantic Coast Line Railway bridge, or in Mingo Creek in said counties below the Averbosboro and Clinton road otherwise than with a hook and line, he shall be guilty of a misdemeanor.

1895, c. 276.

remain as it is.

. That section

2472. In certain streams in Cumberland, New Hanover, Brunswick, and Sampson counties. If any person shall catch or destroy with seines, nets, firearms, bows and arrows, or by muddying or stirring the waters, or by striking any fish of any kind in the waters of Black or South rivers, or the waters of Big Coharie, Little Coharie, Bear Skin, and Big Swamps in the counties of New Hanover, Sampson, Cumberland, and Harnett, and of the waters of Six Runs in the counties of New Hanover and Sampson, and of the waters of the Cape Fear River in the counties of New Hanover and Brunswick, and of the northeast branch of the Cape Fear River in the county of New Hanover, between the fifteenth days of May and August of each year, he shall be guilty of a misdemeanor, and fined not to exceed five dollars.

Code, s. 3409; 1889, c. 414; 1871-2, c. 152; 1879, c. 283; 1881, c. 369.

remain as it is.

That section

2473. Obstructions in South Fork River. No person or corporation shall place or allow to remain in the South Fork River, from its mouth in Gaston County to its forks in Catawba County, any obstruction to the free passage of fish up said stream: *Provided*, this section shall not apply to milldams where the owners thereof shall construct a sufficient fishway over said dams at least ten feet wide which will allow fish to pass over said dams: *Provided further*, this

section shall not apply to dams in existence, or which may be erected for manufacturing or milling purposes. The violation of this section shall be a misdemeanor.

Code, s. 3406; 1879, c. 244, ss. 1, 2; 1881, c. 90.

remain as it is.

That section

2474. Obstructions in Neuse River. Any person who shall construct a dam, put in traps, dutch-net, wire seine, or anything else in Neuse River between its mouth and the Falls of Neuse in Wake County, for the purpose of obstructing the passage of fish in said river, shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days: *Provided*, this section shall not apply to seines, set-nets, running or skimming nets: *Provided*, this section shall not prevent the use of traps in Wayne County, where the trap and its wings do not extend more than one-third across the stream.

Code, s. 3422; 1885, c. 391; 1893, c. 354; 1883, c. 301, ss. 1, 2; 1895, c. 403; 1901, c. 395.

remain as it is.

That section

2475. Regulated in Lumber River. It shall be unlawful for any person to use any seine, net, or gig, or, by muddying the water or by shooting, to catch, take, or kill fish in Lumber River by any means except the ordinary rod, line, and hook, from the first day of March to the first day of November in each and every year; and any person violating this section shall be guilty of a misdemeanor, and shall pay a fine of forty dollars or be imprisoned not more than twenty days.

Code, s. 3404; 1881, c. 288, ss. 1, 2; 1883, cc. 13, 78.

remain as it is.

That section

2476. Fishways to be erected in Haw River. All persons maintaining dams across Haw River in the county of Chatham shall, upon thirty days' notice from the Board of Commissioners of said county, establish fishways in said dams; and if said fishways shall not be made within three months from the service of the notice, said persons so offending shall be guilty of a misdemeanor, and fined at the discretion of the Court.

Code, s. 3402; 1881, c. 343, ss. 1, 2.

remain as it is.

That section

2477. Regulated in Nantahala River. If any person shall use any drag-net, basket, or seine for the purpose of catching fish in Nantahala River or its tributaries, he shall be guilty of a misdemeanor, and fined not less than five nor more than twenty dollars for each offense, one-half to go to the school fund of the

county where such offense is tried, and the other half to the informer; and whenever the Nantahala River forms the dividing line between any counties persons offending against this section may be prosecuted and punished in the courts of the counties between which the said river constitutes the dividing line.

Code, s. 3401; 1881, c. 30, ss. 1, 3.

remain as it is.

That section

2478. Robbing nets. If any person shall, without authority of the owner, take any fish from any nets of any kind, he shall be guilty of a misdemeanor.

Code, s. 3418; 1883, c. 137, s. 5.

shall be amended so that the following shall be added to the section: "and shall be fined not less than fifty dollars or imprisoned not less than thirty days."

That section

2479. Obstructions in certain streams in Henderson County. No person shall make, construct, or build any dam, drag-net, or seine across more than three-fourths of the French Broad, Mills, Green, or Broad rivers, or any of their tributaries, in Henderson County, so as to prevent or hinder the free passage of fish in said rivers and their said tributaries, and any person making or using any dam, drag-net, or seine in said streams shall leave open and unobstructed to the free passage of fish at least one-fourth of said streams, in width, on the side most favorable to the passage of fish. Any person offending against this section shall be fined not more than ten dollars for each twenty-four hours said streams are so obstructed, one-half to the party suing for the same and the other half to the school fund in said county; and any person violating this section shall, in addition to the penalty prescribed, be guilty of a misdemeanor: *Provided*, this section shall not apply to dams for manufacturing purposes.

Code, s. 3425; 1885, c. 58.

remain as it is.

That section

2480. Trout in Cataloochee Creek, Haywood County. If any person shall fish for trout in Cataloochee Creek or its tributaries in Haywood County, and offer such trout for sale as a matter of traffic, or shall fish for trout in such streams without permission from the owners of the land contiguous thereto, he shall be guilty of a misdemeanor, and be fined not more than twenty dollars or imprisoned not more than ten days.

1885, c. 61.

NOTE.—For manner of establishing prior right of fishery, see ss. 1697, 1698.

remain as it is.

That section

2481. Mulletts in Brunswick County. If any person, firm, or corporation shall fish for and catch any mulletts with any purse-seine or purse-net in the waters within the limits of Brunswick County, extending to the extreme limits of the State's jurisdiction in and over said waters—and for the purpose of this section any portion of any water within a distance of three nautical miles from the outer shores of said county shall be deemed the waters of said county—or if the master or any employee on any steamboats engaged in fishing for menhaden or fatbacks shall discharge from said boat fish offal, blood, or slime within a distance of one-half a mile of any established mullet fishery on the Brunswick County coast between the first of August and the thirty-first of December of each year, he shall be guilty of a misdemeanor, and upon conviction shall be fined or imprisoned at the discretion of the Court. For the purposes of this section an established fishery is declared to be that point on the beach occupied by the surfboat and seine in regular use.

1905, c. 748.

remain as it is.

That section

2482. Fishing within twelve miles of Grandfather Mountain. If any person shall take, catch, or kill any kind of fish in the waters of Linville River or in any other stream within twelve miles from the summit of Grandfather Mountain in Mitchell County, without the written consent of the owners or lessees of the land through which said streams flow, or shall throw or empty into said river or streams any matter or substance deleterious or injurious to the life of mountain trout, he shall be deemed guilty of a misdemeanor, and shall be fined not more than fifty dollars or imprisoned not more than thirty days. If any person be seen at or near said stream or streams with net, seine, rod, or any other kind of fishing tackle, the same shall be *prima facie* evidence of the violation of this section.

1905, c. 113.

remain as it is.

That section

2483. Fish-traps in Cape Fear River. If any person shall construct, operate, or maintain any fish-traps in the Cape Fear River, or shall fail to remove all traps now in the channel of said river within sixty days from the first day of March, one thousand nine hundred and five; or shall fail on the first day of June of each year to remove the slats or fingers from any fish-trap allowed to be operated in said river under this section, he shall be guilty of a misdemeanor. This section shall not apply to Brunswick or New Hanover counties or to a fish-trap which extends to not more than one-third the channel of said river.

1905, c. 500.

remain as it is.

That section

2484. Kitty Hawk Bay. If any person shall take, catch, or capture any fish with nets or other appliances in the waters of Kitty Hawk Bay and its tributaries, that part lying in Dare County, between the thirtieth day of April and the fifteenth day of October of each year, or shall sell or ship out of the county any chub or perch between said dates, he shall be guilty of a misdemeanor, and fined not more than fifty dollars or imprisoned not more than thirty days. Nothing in this section shall prevent any citizen from catching fish at any time for home consumption.

1905, c. 363.

remain as it is.

Besides the suggestions and recommendations regarding the present laws as they stand on the statute-books, the committee would recommend the following general legislation :

NEW GENERAL LAWS.

Section Early closing season for shad and alewife or her-ring. All shad apparatus on the Cape Fear River below the mouth of Black River shall be taken out of the river by April the twentieth, and all above this point shall be taken out by May the first; in North East Cape Fear River below Castle Hayne all shad apparatus shall be taken out by April the twentieth and all above that point by May first; in the Black and other tributaries of the Cape Fear River all shad apparatus shall be taken out by May first; in the Neuse River all gill-nets used for shad and alewife fishing shall be taken out of the river by April tenth; but all other shad and alewife apparatus in the Neuse River at or below the town of New Bern shall be taken out by May first and all above that town by May tenth; in Pamlico and Pungo rivers all gill-nets operated for shad and alewife fishing shall be taken out by April fifth, and all other alewife and shad apparatus shall be taken out by May first; in Tar River all shad and alewife apparatus shall be taken out of the river by May tenth; in Pamlico, Roanoke, Croatan, and Albemarle sounds east of Perquimans River on the north and Ship Point on the south (this to apply to the tributaries of the sound in this section) all gill-nets shall be taken out by April fifth, and all shad and alewife apparatus shall be taken out by April twenty-eighth, and in that portion of the Albemarle Sound west of the above points as far as Horney Blow Point on the north and Mackey's Creek on the south all gill-nets shall be taken out by April tenth, and all other shad and

alewife apparatus shall be taken out by May twelfth; thence west as far as the mouth of Chowan River, all gill-nets operated for shad and alewife fishing shall be taken out by April fifteenth, and all other shad and alewife apparatus shall be taken out by May twelfth, these dates to apply to the tributaries of this section of Albemarle Sound; in Chowan River all shad and alewife apparatus shall be taken out of the river by May fifteenth. If any person shall set or fish any net wilfully in violation of this section, he shall be guilty of a misdemeanor and fined not less than fifty dollars: *Provided*, that all pound-nets in any part of the waters mentioned in this section that are cut down in order to rid them of moss are to be considered as fulfilling the law.

Section Double seining. All double seining in any of the waters or rivers of the State, and the hauling or drawing two seines in succession over the same bottom or within four hundred yards of that bottom is hereby prohibited, and any person violating this section shall for each violation be fined not less than two hundred and fifty dollars nor more than five hundred dollars.

Section Protection of sturgeon. No person shall set or fish any sturgeon-net in the inland waters of North Carolina for a period of five years from the date of the passage of this act; and all sturgeons less than five feet long caught in any other manner whatever shall be returned to the water alive, and any person violating this section shall be guilty of a misdemeanor and fined not less than fifty dollars or imprisoned not less than twenty days; and the possession of any sturgeon less than five feet in length shall be *prima facie* evidence that the person having the same is violating this section. For the purposes of this act inland waters are defined as all waters of the State lying within the ocean inlets and the mouths of rivers and bays opening directly into the sea.

Section Rockfish. If any person shall offer for sale any rockfish weighing less than one-half pound, he shall be guilty of a misdemeanor and be fined ten dollars for every offense.

Section Purse-net. No person shall use or fish a purse-net for rockfish or perch in any of the waters in North Carolina, except in the open sea, and any person offending against this section shall be fined not less than fifty dollars for each offense.

Section Shad and herring. Any person who shall catch or cause to be caught any shad or herring in the waters of the State of North Carolina for any other purpose than as food shall be guilty of a misdemeanor and fined not less than fifty dollars or imprisoned not less than thirty days.

Section Fishing on Sunday. If any person shall fish, haul, set, draw, or place in the water for fishing purposes, any net from midnight of Saturday night to midnight of Sunday night, he shall be guilty of a misdemeanor and fined not less than twenty-five dollars for each and every offense.

Section License to fish. Each and every person, firm, or corporation before commencing or engaging in any kind of fishing in the State shall file with the Sheriff of the county in which he desires to fish, a sworn statement as to the number and kind of nets, seines, or other apparatus that it is intended to use in fishing. Upon filing this statement the Sheriff shall issue to the said party or parties a license as prescribed by law; said applicant shall pay to the Sheriff a license fee equal in amount to the fee or tax prescribed by law and an additional fee of twenty-five cents for issuing said license and receiving said tax. This license shall extend through a period of twelve months from date of its issue. Any person who shall wilfully use for fishing purposes any kind of net whatever without having first complied with the provisions of this section shall be guilty of a misdemeanor and be fined twenty-five dollars for each and every offense.

Section Licenses reported monthly. The Sheriff of each county in which licenses to fish are issued shall, on or before the tenth day of each month, mail to the Fish Commissioner a statement showing all licenses issued during the preceding month, to whom issued, and for what purpose. The Commissioner shall have prepared and mailed to each inspector a list of all persons, firms, or corporations to whom license has been issued, together with a statement as to the number and character of the nets said licensee is authorized to use.

Section License fees collected. All moneys collected by the sheriffs of the respective counties in which they serve, representing license taxes and fees for fishing privileges, shall be paid over to the Fish Commissioner on the first day of each month.

Section License tax. The following license tax is hereby levied upon the different fishing appliances used in the waters of North Carolina:

Anchor gill-nets, 20 cents per 100 yards or fraction thereof.

Stake gill-nets, 10 cents per 100 yards or fraction thereof.

Drift gill-nets, 20 cents per 100 yards or fraction thereof.

Pound-nets, \$1.00 each.

Seine and drag-nets under 100 yards, \$1.00 each.

Seine and drag-nets over 100 yards and under 300 yards, \$1.00 per 100 yards or fraction thereof.

Seine and drag-nets over 300 yards and under 1,000 yards, \$1.25 per 100 yards or fraction thereof.

Seine and drag-nets over 1,000 yards, \$1.75 per 100 yards or fraction thereof.

Outside mullet-seines fished in ocean, \$2.00 per 100 yards.

Purse-nets used with power boats, \$3.00 per 100 yards or fraction thereof.

Purse-nets used with sail-boats not reinforced with steam or other power, \$2.50 per 100 yards or fraction thereof.

Fyke-nets, 25 cents each.

Minor nets, 20 cents each.

TERRAPIN INDUSTRY.

The terrapin industry was thoroughly discussed and a paper prepared by Mr. R. E. Coker for the North Carolina Geological Survey on the Cultivation of the Diamond-back Terrapin was submitted to the committee. After thorough and careful consideration, it was decided that with a slight modification, the present laws relating to the terrapin were adequate, if enforced, to protect this industry and insure an increase in the number of terrapins in North Carolina waters. The committee, therefore, recommend that Section 2369, which reads as follows, remain unchanged:

2369. Use of drag-nets by non-residents for catching terrapin forbidden. If any person who is not a citizen and who has not resided in the State continuously for the preceding two years shall use any drag-net or other instrument for catching terrapin he shall be guilty of a misdemeanor.

Code, s. 3375, 3376.

2370. Diamond-back terrapin protected. If any person shall take or catch any diamond-back terrapin between the fifteenth day of April and the fifteenth day of August of any year, or any diamond-back terrapin at any time, of less

size than five inches in length upon the bottom shell, or shall interfere with or in any manner destroy any eggs of the diamond-back terrapin, he shall be guilty of a misdemeanor, and shall be fined not less than five dollars nor more than ten dollars for each and every diamond-back terrapin so taken or caught, and a like sum for each and every egg interfered with or destroyed: *Provided*, this section shall not apply to parties empowered by the State to propagate the said diamond-back terrapin; and the possession of any diamond-back terrapin between the fifteenth days of April and August shall be *prima facie* evidence that the person having the same has violated this section. It shall be the duty of all sheriffs and constables to give immediate information to some justice of the peace of any violation of this section.

Code, s. 3377; 1899, c. 582; 1881, c. 115, ss. 1, 6.

It is recommended that this paragraph be changed so that it will read as follows:

If any person shall take or catch or have in his possession any diamond-back terrapin between the first day of March and the thirty-first day of August of any year, or any diamond-back terrapin at any time, of less size than five inches in length upon the bottom shell, or shall interfere with, or in any manner destroy any eggs of the diamond-back terrapin, he shall be guilty of a misdemeanor, and shall be fined not less than five dollars, nor more than ten dollars, for each and every diamond-back terrapin so taken or caught, and a like sum for each and every egg interfered with or destroyed: *Provided*, that this section shall not apply to parties empowered by the State to propagate the said diamond-back terrapin; and the possession of any diamond-back terrapin between the first day of April and thirty-first day of August shall be *prima facie* evidence that the person having the same has violated this section: *Provided further*, that the provisions of this act shall apply to any person, firm, or corporation receiving or having for transportation undersized terrapins, or during the closed season terrapins of any size whatever. It shall be the duty of all sheriffs and constables to give immediate information to some justice of the peace of any violation of this section.

The committee in framing this act has given serious consideration to the fact that at the present time the quantity of diamond-back terrapin in the waters of North Carolina is extremely limited and is growing less and less every year, and unless some stringent remedy is employed to protect the terrapin, it is the question of but a few years when this valuable food product will be entirely exterminated. It is, therefore, absolutely essential that the closed season shall extend from the first day of March through the thirty-first day of August and that this law shall be vigorously enforced.

OYSTER INDUSTRY.

After mature deliberation the committee were of the unanimous opinion that a Shell-fish Commission should be established and inaugurated by the Legislature on similar lines as those relating to the formation of the Fish Commission; believing that if legislation is obtained regarding the cultivation of the oyster and the leasing of bottoms for that purpose, it will require the Shell-fish Commissioner and the Deputy Commissioner to devote all their time to the carrying out of the duties of their office. The committee, therefore, unanimously recommend the organization of a Shell-fish Commission according to the following:

1. North Carolina Shell-fish Commission. The Shell-fish Commission shall, except as in this act otherwise provided, consist of a single Commissioner. He shall be appointed by the Governor by and with the advice and consent of the Senate within thirty days after the passage of this act. He shall be responsible for the carrying out of the duties of his office to the Geological and Economic Survey Board, and shall make semi-annual reports to them. The term of office of such Commissioner and his successors in office shall be four years or until their successors are appointed and qualified, and in case of vacancy in the office, the appointment shall be to fill the vacancy. The said Commissioner shall appoint a Deputy Commissioner, who, during the absence or inability to act of the Commissioner, shall have and exercise all of the powers of the Commissioner. The Shell-fish Commissioner and Deputy Commissioner shall each execute and file with the Secretary of State bonds in the sum of seven thousand and five thousand dollars respectively, with sureties to be approved by the Secretary of State, conditioned for the faithful performance of their duties and to account for and pay over, pursuant to law, all moneys received by them in their office. The Shell-fish Commissioner shall take and subscribe an oath to support the Constitution and for the faithful performance of the duties of his office, which oath shall be filed with the bond. The Deputy Commissioner may be removed from his office for cause by the Commissioner, who may appoint his successor.

Inspectors, how appointed; term; salary; bond; oath of office. The Shell-fish Commissioner shall appoint, from the counties within which they are to perform their duties, a sufficient number of inspect-

ors, who shall serve during the oyster season, and may remove them for cause. He shall fix the compensation of the inspectors at not exceeding fifty dollars a month while on duty, and shall designate the length of service, the time when the inspectors go on duty and when they go off. The inspectors shall give bond in the sum of five hundred dollars, payable to the State of North Carolina, conditioned for the performance of the duties of their office, and the faithful accounting for all moneys received, which bond shall have at least two sufficient sureties, to be justified before, approved by, and filed with the Clerk of the Superior Court of the county where they reside, and shall take, subscribe, and file with such Clerk an oath of office. They shall be paid only for the time they serve.

Office and clerical force. The Commissioner shall have an office in some town conveniently located to the oyster-beds of the State, and he is authorized to employ such clerks as may be necessary for the proper carrying on of the work of his office.

Equipment. The Shell-fish Commissioner is authorized, by and with the consent of the Geological and Economic Survey Board, to purchase or rent such boats, dredges, and other equipment as may be necessary to enable him and his deputies to carry out the duties of his office as specified in this act.

Duties of the Shell-fish Commissioner. The Shell-fish Commissioner shall have a general supervision over every branch of the shell-fish industry, including the oyster, clam, scallop, and other mollusca, and see that the laws regulating the same are rigidly enforced. He shall collect and compile statistics showing the annual product of the oysters, clams, and other mollusca that are taken out of the waters of the State, and the capital invested and the apparatus employed; he shall have surveyed and marked in a prominent manner those areas of bottoms in the waters of the State in which oyster-tonging or dredging is prohibited by law, or those areas which are leased for the purpose of the cultivation of oysters or clams; he shall be responsible for the collection of all license fees, taxes, fines, or other imposts upon any of the shell-fish fisheries, and shall receive all fines imposed for the infraction of the shell-fish laws, and shall collect all rentals for bottoms leased for oyster or clam cultivation, and shall pay same into the State Treasury to the credit of the Shell-fish Commission fund to be drawn upon as directed by the Geological and

Economic Survey Board; he shall see that the laws regulating the catching and handling of oysters, clams, and other mollusca are enforced; that no illegal methods are used in catching, selling, or shipping; that the cull law is rigidly enforced, and that only proper and legal methods are used in buying and selling. He shall prosecute all violations of the law, and whenever it is necessary he may employ counsel for this purpose. He shall in his official capacity have power to administer oaths and to send for and examine persons and papers; he shall, on or before the twenty-fifth day of each month, mail to the Treasurer of the State a consolidated statement showing the amount of taxes collected during the preceding month, and by and from whom collected. He shall make a semi-annual report to the Geological and Economic Survey Board, setting forth in detail an account of his official acts, the condition of the oyster and other shell-fish industries in all their branches, and shall recommend such additions to or modifications of existing laws relating thereto as he may deem proper and necessary.

Arrests without warrant, when and how made. The Shell-fish Commissioner, Deputy Commissioner, and inspectors shall have power, with or without warrants, to arrest any person violating the fishery laws.

Power to take oysters and clams. The Shell-fish Commissioner and the United States Bureau of Fisheries may take and cause to be taken for scientific purposes any oysters, clam, or other mollusca at any time from the waters of the State, any law to the contrary notwithstanding.

Salaries. The salary of the Shell-fish Commissioner shall be fifteen hundred dollars per year and the expenses necessarily incurred by him in the discharge of his duties. The salary of the Deputy Shell-fish Commissioner shall be nine hundred dollars per year and the expenses necessarily incurred by him in the discharge of his duties. The salaries of clerks and of scientific assistants which may be employed from time to time are to be fixed by the Geological and Economic Survey Board.

No interest in oyster, clam, or other mollusca fisheries. The Shell-fish Commissioner, Deputy Commissioner, and inspectors shall not be interested in any oyster, clam, or other mollusca fishing industry in North Carolina.

Revenue. All license fees, taxes, rentals of oyster and clam bottoms, fines or other imposts upon the oyster, clam, scallop, and other mollusca fisheries, or fines imposed for infraction of the oyster, clam, and other mollusca fishery laws, in whatever manner collected, shall be paid to the State Treasurer to the credit of the Shell-fish Commission fund, to be drawn upon as directed by the Geological and Economic Survey Board, and shall constitute the revenue of the Shell-fish Commission.

If the organization of a Shell-fish Commission as outlined above is incorporated, then Sections 2398, 2403, 2404, 2405, 2406, 2407, 2422, which are given beyond, should be repealed.

PRESENT LAWS RELATING TO OYSTERS.

The present laws relating to oysters and clams as given in the Code Revisal of 1905 were then considered, the committee passing the following resolutions:

That section

2371. Natural, defined. A natural oyster or clam bed, as distinguished from an artificial oyster or clam bed, shall be one not planted by man, and is any shoal, reef, or bottom where oysters are to be found growing in sufficient quantities to be valuable to the public.

1893, c. 287, s. 1.

be amended so as to read as follows:

In the waters of North Carolina a natural oyster reef or bottom shall be considered and defined as an area containing not less than a continuous area of one acre of the bottom on which oysters are found growing natural at the time or have been so found during a period of five years preceding the time at which the decision be made and in sufficient quantities to make their fishing profitable by means of hand-tongs on such ground as are reserved exclusively for tonging, or dredges on such beds as are designated for dredging: *Provided*, that no intervals of less than one hundred yards shall be considered as breaking the continuity of the bed.

That section.

2372. Planted in certain territory. Any inhabitant of this State may make a bed in any of the waters of this State, except that part designated as lying south of Roanoke and Croatan sounds and north of Core Sound, and lay down or plant oysters or clams therein, having first obtained license as hereinafter directed from the Superior Court Clerk of the county wherein such bed may be, and he

may stake out the grounds so as to include not exceeding ten acres with good and substantial stakes, extending at least two feet above high water-mark, and placed at such intervals as to make the boundaries of such bed or garden distinctly known; and every person who shall obtain such license shall hold the same and have exclusive privilege thereof to him, his heirs and assigns. But no person may have more than one such bed in the same county: *Provided*, nothing herein shall be construed to affect the rights of any owner or proprietor of lands in which there may be creeks or inlets, or which may be adjacent to any navigable waters, or to authorize any person to appropriate to his own use or to stake off and enclose any natural oyster or clam bed, or in anywise to infringe the common right of the citizens of the State to any such natural bed or to obstruct the free navigation of the waters aforesaid.

Code, s. 3390; 1883, c. 332, ss. 1, 2.

be repealed, provided the legislation relating to the cultivation of the oyster is passed.

That section

2373. How license is obtained. Whenever a license is desired according to the preceding section, the Clerk of the Superior Court of the county wherein the proposed oyster or clam bed may be may, in his discretion, grant a license to make such oyster or clam bed to any inhabitant of this State who shall apply therefor as herein provided; such applicant shall first stake off the proposed oyster or clam bed as provided in the preceding section, and shall publish a notice for thirty days at the court-house door of the county wherein said bed is proposed, designating the location thereof as near as may be and the day when he will apply for the issuing such license. Upon the day named in said notice upon which application for such license is to be made any inhabitant of such county shall have the right to appear before said Clerk and object to the issuing of such license by filing an affidavit stating that the proposed oyster or clam bed is a natural oyster or clam bed. If the said applicant shall refuse to file an affidavit denying the proposed oyster or clam bed is a natural bed, the said Clerk shall refuse to grant such license. If such applicant shall file an affidavit denying that such proposed bed is a natural bed, it shall be the duty of such Clerk to transmit said affidavits to the next term of the Court of said county, and at said term the issue shall be tried to determine whether the proposed bed is a natural bed, and after such trial the said Clerk shall grant or refuse said license in accordance with the judgment rendered upon the determination of such issue.

Code, s. 3391; 1893, c. 287, s. 2.

be repealed.

That section

2374. County Commissioners to cause survey to be made. The Board of County Commissioners may in their discretion cause to be made, not oftener than once in twelve months, a survey and examination of any and every such oyster or clam bed or garden in their county, the result of which examination or survey shall be reported under oath to the Clerk of the Superior Court; and if it be

found that the holder of such license as aforesaid has included within his stakes any natural oyster or clam bed, or a space containing more than ten acres, he shall forfeit such license and all the rights and privileges thereto belonging; further, if the holder of such license fail for the space of two years either to use such bed or to keep it properly designated by stakes, he shall forfeit such license and all the rights and privileges therein granted.

Code, s. 3392; 1883, c. 332, s. 4.

be repealed, provided the legislation relating to the cultivation of the oyster is passed.

That section

2375. Under control of the State. The State shall exercise exclusive jurisdiction and control over all shell-fisheries which are or may be located in the boundaries of the State south of Roanoke and Croatan sounds and north of Core Sound, and for the purposes of this chapter the southern boundary-line of Hyde County shall extend from the middle of Ocracoke Inlet to the Royal Shoal lighthouse, thence across Pamlico Sound and with the middle line of the Pamlico and Pungo rivers to the dividing line between the counties of Hyde and Beaufort, and the northern boundary-line of Carteret County shall extend from the middle of Ocracoke Inlet to the Royal Shoal lighthouse, thence to the Brant Island Shoal lighthouse, thence across Pamlico Sound to a point midway between Maw Point and Point of Marsh, and thence with the middle line of the Neuse River to the dividing line between the counties of Carteret, Craven, or Pamlico, and that portion of Pamlico Sound and the Neuse and Pamlico rivers not within the boundaries of Dare, Hyde, or Carteret counties, and not a part of any other county, shall be in the county of Pamlico, and for the purposes of this chapter and in the execution of the requirements thereof the shore line as now defined by the United States Coast and Geodetic Survey shall be accepted as correct.

1887, c. 119, ss. 1, 2.

be repealed.

That section

2376. How beds entered. Any person a citizen and *bona fide* resident of the State desiring to raise, plant, or cultivate shell-fish upon any ground in the county, and within the territory described in the preceding section, which has not been designated as public ground by the Board of Shell-fish Commissioners and which is not a natural clam or oyster bed, may make application in writing, in which shall be stated as nearly as may be the area, limits, and location of the ground desired, to the entry-taker of the county in which the said area for which application is made is situated, for a franchise for the purpose of raising or cultivating shell-fish in said grounds, and the said entry-taker having received said application shall proceed as with all other entries as provided in the chapter entitled Grants, except that the warrant to survey and locate the ground or grounds shall be delivered to the engineer appointed by the Secretary of State and not to the county surveyor; and the said engineer shall make such surveys in accordance with the provisions of the chapter entitled Grants, except that it

shall not be necessary to employ chain-bearers nor to administer oaths to assistants, nor to make surveys, according to the priority of the application or warrant. No entry shall be made to cover any natural oyster or clam bed as defined in this chapter, nor of any land lying more than two miles from the mainland or from any island.

1887, c. 119, s. 5; 1893, c. 272.

be repealed.

That section

2377. How leased. Any person who is and has been continuously for two years a *bona fide* resident of the State of North Carolina and over twenty-one years of age may lease or enter not more than fifty acres of any bottom where oysters do not naturally grow or on any ground where there is not a sufficient growth of oysters to justify at the time of leasing the gathering of the same for profit. When any person desires to lease or enter any such ground he shall advertise the fact at the court-house and three other places for four weeks in the county where said bottom desired to be leased is located, and advertise in some newspaper published in said county for four weeks, and if there be none published in said county, then in a newspaper published in an adjoining county. Application for such land shall be made to the Clerk of the Superior Court, who shall appoint a man and the applicant shall choose another, which two so chosen shall appoint a third man, and the three shall constitute a board of arbitration, and the said board of arbitration shall inspect the bottom desired to be leased, and if they find the same subject to lease and so report to the Clerk, then it shall be the duty of the said Clerk to issue a lease as herein provided, and for such service the Clerk shall receive the following fees, to-wit: Twenty-five cents for the application, twenty-five cents for the appointment, and twenty-five cents for filing the report of arbitration, and copy-sheet fees for recording such lease and other papers necessary to be recorded. Such bottom shall be surveyed by the county surveyor; all cost and expense to be paid by the lessee, who shall also pay a yearly rental of fifty cents per acre, which rental shall be paid to the Oyster Commissioner and go to the benefit of the oyster fund. A failure to pay rental for two years shall render the lease null and void. No bottom which has been surveyed prior to sixth day of March, one thousand nine hundred and five, need be resurveyed where such leases are plainly marked at that time. The county surveyor shall furnish the lessee a map or plot free of charge. No lease shall be issued for any ground closer than two hundred yards to any natural oyster bed.

1905, c. 525, s. 2.

be repealed, provided that the legislation regarding the cultivation of the oyster is passed.

That section

2378. Secretary of State to issue grant; amount granted limited. The Secretary of State, on receipt of the Auditor's certificate as provided in the chapter on Grants, shall grant to the applicant a written instrument conveying a perpetual franchise for the purpose of raising and cultivating shell-fish in and to the grounds for which application is made; and the said written instrument

of conveyance shall be authenticated by the Governor, countersigned by the secretary and recorded in his office. The date of the application for the franchise and a description of the ground for which such franchise was granted shall be inserted in each instrument, and no grant shall issue except in accordance with a certificate from the engineer appointed by the Secretary of State as to the area, limits, and location of the grounds in which the said franchise is to be granted, and every person obtaining such grant or franchise shall, within three months from the receipt of the same, record said written instrument in the office of the Register of Deeds for the county wherein the said grounds may lie and shall define the boundaries of the said grounds by suitable stakes, buoys, ranges, or monuments; but no franchise shall be given in or to any of the public grounds as determined by the commissioners of shell-fisheries, or to any natural oyster or clam bed, and all franchises granted under this section or any previous law shall be and remain in the grantee, his heirs and legal representatives: *Provided*, that the holder or holders shall make in good faith within five years from the day of obtaining said franchise an actual effort to raise and cultivate shell-fish on said grounds. No grant shall be made to any one person of more than ten acres of any territory, and no person shall hold more than ten acres in any creek unless the same shall be acquired through devise, inheritance, or marriage.

1887, c. 119, s. 6; 1893, c. 272.

be repealed.

That section

2379. Price paid for franchise. Not less than seventy-five cents per acre shall be paid to the State Treasurer for all franchises granted, and in all other respects as to protests of entry and the right of the Secretary of State to sell to any one else at an increased price the chapter on Grants shall apply.

1887, c. 119, s. 7.

be repealed.

That section

2380. Liable to taxation. All grounds taken up or held for the purpose of cultivating shell-fish shall be subject to taxation as real estate, and shall be so considered in the settlement of the estates of deceased or insolvent persons.

1887, c. 119, s. 9.

be repealed.

That section

2381. Books of records of grants kept. The Secretary of State shall keep books of record in which shall be recorded a full description of all grounds granted under the provisions of this chapter, and shall keep a map or maps upon which shall be shown the positions and limits of all public and private grounds.

1887, c. 119, s. 14.

be amended in that "Secretary of State" shall read "Shell-fish Commission," provided the bill creating the Shell-fish Commission is passed.

That section

2382. Form of grants approved by Attorney-General. Entry-takers shall make return to the Secretary of State of all franchises granted under this chapter, in the same manner as provided in the chapter entitled Grants, and the provisions of that chapter are hereby extended so as to cover the grants or franchises in ground for raising or cultivating shell-fish as authorized by this chapter; and all applications, grants, warrants, and assignments of franchises in or to oyster grounds shall be in manner and form as approved by the Attorney-General of the State.

1887, c. 119, s. 12.

be repealed.

CATCHING OYSTERS.

That section

2383. Close season, exception. If any person shall buy or sell oysters in the shell which have been taken from the public grounds or natural oyster-beds of this State between the first day of April and the first day of October in any year, he shall be guilty of a misdemeanor and be fined not more than fifty dollars or imprisoned not more than thirty days: *Provided*, that oysters may be taken with hand-tongs only during the month of April in any year, to be used for planting on private grounds, entered and held under the laws of this State: *Provided further*, that oysters may be taken with hand-tongs only for home consumption: *Provided further*, that coon oysters may be taken from October first to May first of each year in the waters of Onslow and Carteret counties: *Provided, also*, that it shall be lawful to take or catch oysters on public oyster-grounds north of the line running from Point Peter to Duck Island, except between a line running from the east end of Hog Island to the beach and from Ballast Point to the beach in Dare County, to be sold to residents or non-residents, from April first to May fifteenth of each year, upon the payment by the purchaser of a tax of one and one-half cents per tub.

1903, c. 516, s. 22; 1905, c. 525, ss. 5, 8.

be amended so as to read as follows:

If any person shall buy or sell oysters in the shell which have been taken from the public grounds or natural oyster-beds of this State between the first day of April and the fifteenth day of October in any year, he shall be guilty of a misdemeanor, and be fined not less than fifty dollars or imprisoned not less than thirty days: *Provided*, that oysters may be taken with hand-tongs only during the month of April in any year, to be used for planting on private grounds, entered and held under the laws of this State, upon the condition further that they shall not be removed from said private beds within a period of three months from time of planting: *Provided further*, that oysters may be taken with hand-tongs only for home consumption: *Provided further*, that coon oysters may be taken from October first to May

first of each year in the waters of Onslow and Carteret counties: *Provided, also*, that it shall be lawful to take or catch oysters in public oyster-grounds north of the line running from Point Peter to Duck Island, except between a line running from the east end of Hog Island to the beach and from Ballast Point to the beach in Dare County, to be sold only to residents of the State for planting purposes, from April first to May fifteenth of each year, upon the payment by the purchaser of a tax of one and one-half cents per tub.

That section

2384. At night or on Sunday. If any person shall catch or take any oysters from any of the public grounds or natural oyster-beds of the State at night or on Sunday, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1903, c. 516, s. 16.

remain as it is.

That section

2385. Illegal dredging. If any person shall use any scoops, scrapes, or dredges for catching oysters, except at the times and in the places in this chapter expressly authorized, or shall between the fifth day of April and the fifteenth day of November of any year carry on any boat or vessel any scoops, scrapes, dredges, or winders, such as are usually or can be used for taking oysters, he shall be guilty of a misdemeanor.

1903, c. 516, ss. 13, 14, 15.

remain as it is.

That section

2386. Catching oysters without license. If any person shall catch oysters from the public grounds of the State without having first obtained a license according to law, or shall employ any person as agent or assistant, or shall as the agent or assistant of any person catch oysters from the public grounds, without all of said persons having first obtained a license according to law, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1903, c. 516, s. 6.

remain as it is.

That section

2387. Using boats not licensed. If any person shall use any boat or vessel in catching oysters, which boat has not been licensed according to law, and which is not in all respects complying with the law regulating the use of such vessels, he shall be guilty of a misdemeanor, and shall be fined not more than fifty dollars nor less than ten dollars or imprisoned not more than thirty nor less than ten days for the first offense, but for the second or subsequent offense he shall be guilty of a misdemeanor, and punished at the discretion of the Court.

1903, c. 516, s. 8.

remain as it is.

That section

2388. Displaying false number on boat. If any person shall display any other number on their sail than the one specified in their license, or display a number when the boat or vessel has not been licensed, he shall be guilty of a misdemeanor and shall be fined not less than twenty-five dollars.

1903, c. 516, s. 27.

remain as it is.

That section

2389. Failure to stop and show oyster license. If any person using a boat or vessel for the purpose of catching oysters shall refuse to stop and exhibit his license when commanded to do so by the Oyster Commissioner, Assistant Commissioner, or any inspector, he shall be guilty of a misdemeanor, and be fined not less than twenty-five dollars nor more than fifty dollars.

1903, c. 516, s. 26.

remain as it is.

That section

2390. False statement in application for oysterman's license. If any person shall make any false statement for the purpose of procuring any license which may be required by law to catch oysters, or to engage in the oyster industry, he shall be guilty of perjury and punished as provided by law.

1903, c. 516, s. 17.

remain as it is.

That section

2391. Dredging in prohibited waters. If any person, after the Governor has by proclamation suspended the right to use scoops, scrapes, or dredges on the public grounds or natural oyster-beds of the State, shall during the time of such suspension and in the waters as to which the right has been suspended, use such instruments or implements to catch oysters from any of the public grounds or natural oyster-beds of the State, he shall be guilty of a misdemeanor, and be fined not less than five hundred dollars or imprisoned not less than twelve months, and the boat or vessel used for this purpose shall be forfeited and shall be seized, advertised, and sold by the Oyster Commissioner or by the inspectors in the county wherein said illegal act was committed, and the proceeds paid into the oyster fund. In any prosecution for the violation of the provisions of this section against the master or owner of a boat or vessel, proof that said boat or vessel was equipped with scoop, scrape, or dredge or other implement or instrument for catching or taking oysters other than ordinary oyster tongs, shall be *prima facie* evidence of the defendant's guilt.

1903, c. 516, s. 19.

remain as it is.

That section

2392. Selling oysters not culled. If any person shall sell or offer for sale, transport or offer to transport out of the State, or from one point in the State to another, or have in his possession any oysters which have not been properly culled according to law, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1903, c. 516, s. 3.

be repealed and the following substituted for it:

A captain of any run or buy boat who shall purchase oysters which have not been properly culled according to law shall, upon conviction, be fined fifty dollars or imprisoned thirty days, and the having of uncultured oysters aboard his boat shall be *prima facie* evidence of his having purchased them.

It shall be unlawful for any person, firm, or corporation to purchase oysters which have not been properly culled according to law, and for each violation shall, upon conviction, be fined fifty dollars or imprisoned thirty days: *Provided*, that when any person, firm, or corporation shall furnish the captain of any run or buy boat with funds with which to purchase oysters, they shall not be held responsible for his acts and shall not be deemed the purchaser of such oysters.

That section

2393. Oysters, where purchased to be carried out of the State. If any person shall purchase and load on any vessel or boat any oysters to be carried out of the State in the shell, except at the following places, to-wit, the south end of Roanoke Island, Stumpy Point Bay, Parched Corn Bay, Wysocking Bay, West Bluff Bay, Great Island Narrows, or Swan Quarter Bay (as the Oyster Commissioner may determine), Portsmouth, Ocracoke, Bay River, mouth of Rose Bay, or Harbor Island; or if any person shall load more than one boat or vessel at any of said places at one and the same time, or if any person shall load any boat or vessel with oysters to be carried out of the State without such vessel having an inspector on board at the time the oysters are delivered, or shall carry any vessel loaded or partly loaded with oysters through the canals without a certificate showing that the oysters have been inspected and the taxes thereon paid, he shall be guilty of a misdemeanor, and be fined not more than fifty dollars or imprisoned not more than thirty days.

1903, c. 516, s. 17.

be repealed and the following substituted for it:

Any corporation domiciled in this State with their factories, shucking plants, and shipping depots located in this State, may enjoy the rights of fishing oysters from the natural reefs and of bedding oysters on leased bedding grounds: *Provided*, such oysters are canned,

shucked, or packed in this State, or shipped raw in shells from a shipping depot in this State for consumption either in or out of this State; but no person, firm, or corporation shall ship oysters out of this State for canning or packing out of this State. As it is the desire of the State to encourage the planting of shells on barren bottoms in this State, no oysters in shell shall be shipped out of this State without the shipper first obtains from the Shell-fish Commissioner of North Carolina permit so to do, and for which no charge shall be made by said Commissioner.

That section

2394. Unloading oysters on Sunday or at night. If any person shall unload any oysters from any boat, vessel, or car at any factory or house for shipping, shucking, or canning oysters on Sunday, or after sunset or before sunrise, he shall be guilty of a misdemeanor, and be fined not more than fifty dollars or imprisoned not more than thirty days: *Provided*, whenever any boat or vessel shall have partially unloaded or discharged its cargo before sunset, the remainder of said load or cargo may be discharged in the presence of an inspector.

1903, c. 516, s. 16.

remain as it is.

That section

2395. Dealing in oysters without license. If any person shall engage in the business of buying, canning, packing, shipping, or shucking oysters without having first obtained a license as required by law, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1903, c. 516, s. 9.

remain as it is.

That section

2396. Dealer failing to keep record. If any person engaged in buying, packing, canning, shucking, or shipping oysters shall fail to keep a permanent record of all oysters bought by him or caught by him, or by persons for him, when and from whom bought, the number of bushels and the price paid therefor, or shall fail upon demand to exhibit such record as required by law, or shall fail to verify the same, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1903, c. 516, s. 5.

remain as it is.

That section

2397. Evidence of illegal dredging. If any boat or vessel shall be seen sailing on any of the waters of this State during the season when the dredging of oysters is prohibited by law in the same manner in which they sail to take or catch oysters with scoops, scrapes, or dredges, the said boat or vessel shall be pursued by any officer authorized to make arrests, and if said boat or vessel apprehended by said officer shall be found to have on board any wet oysters or the scoops, scrapes, dredges, or lines, or deck wet, indicating the taking or catching of oysters at said time, and properly equipped for catching or taking oysters with scoops, scrapes, or dredges, such facts shall be *prima facie* evidence that said boat or vessel has been used in violation of the provisions of the law prohibiting the taking or catching of oysters with scoops, scrapes, or dredges in prohibited territory, or at a season when the taking or catching of oysters with scoops, scrapes, or dredges is prohibited by law, as the case may be.

1903, c. 516, s. 28.

be amended so that the following is added to this law :

Any one violating this act shall be guilty of a misdemeanor, and fined not less than fifty dollars or imprisoned not less than thirty days.

That section

2398. Arrests without warrant, when and how made. The Oyster Commissioner, Assistant Oyster Commissioner, and inspectors shall have power with or without warrant to arrest any person violating any of the oyster laws.

1903, c. 516, s. 2.

remain as it is.

That section

2399. Using illegal measures for oysters. If any person shall in buying or selling oysters use any measure other than that prescribed by law for the measurement of oysters, or if any dealer in oysters shall have in his possession any measure for measuring oysters other than that prescribed by law, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

1903, c. 516, s. 12.

remain as it is.

That section

2400. Catching oysters for lime. If any person shall take or catch any live oysters to be burned for lime or for any agricultural or mechanical purpose, he shall be guilty of a misdemeanor, and be fined not exceeding fifty dollars or imprisoned not exceeding thirty days.

Code, s. 3389; 1885, c. 182.

remain as it is.

That sections

2401. Larceny of oysters on private beds. Any person who shall feloniously take, catch, or capture or carry away any shell-fish from the bed or ground of another, shall be guilty of larceny and punished accordingly.

1887, c. 119, s. 15.

and

2402. Oysters caught at night; injury to private beds. If any person shall wilfully commit any trespass or injury with any instrument or implement upon any ground upon which shell-fish are being raised or cultivated, or shall remove, destroy, or deface any mark or monument lawfully set up for the purpose of marking any grounds, or who shall work on any oyster-ground at night, he shall be guilty of a misdemeanor. But nothing in the provisions of this section shall be construed as authorizing interference with the capture of migratory fishes or free navigation or the right to use on any private grounds any method or implement for the taking, growing, or cultivation of shell-fish.

1887, c. 119, s. 11.

be repealed and the following substituted for them:

Section Any person who shall wilfully and without authority take or remove oysters from any land leased under the laws of the State of North Carolina, or shall wilfully injure or interfere with the oysters of such land in any manner, or injure oysters thereupon situated, or wilfully remove, alter, or interfere with the stakes, buoys, or monuments marking the same, shall, upon conviction thereof, for the first offense be sentenced to imprisonment in jail or in the penitentiary, in the discretion of the Court, for not less than three months and not more than two years, and for the second or any subsequent offense be sentenced to imprisonment in the penitentiary for not less than two years and not more than five years.

Section Any person who shall work a dredge, scrape, or pair of tongs or any other implement for the taking of oysters upon any land leased under the provisions of this act, without the consent of the lessee or owner, or who shall, while upon or sailing over any such ground or bed, cast, haul, or have overboard any such dredge, scrape, or pair of tongs or other implement for the taking of oysters under any pretense or for any purpose whatever, without the consent of such lessee or owner, upon conviction thereof shall for the first offense be fined not less than fifty dollars nor more than two hundred and fifty dollars or, in the discretion of the Court, be imprisoned in the jail

or the penitentiary for not less than three months nor more than one year, or shall be both so fined and imprisoned; and for the second or any subsequent offense shall be sentenced to imprisonment in the penitentiary for not less than two years nor more than five years.

That sections

2403. Commissioner and assistant, how appointed, removed; term; salary; bond; oath of office. For the purpose of enforcing the oyster law, the Governor shall appoint an Oyster Commissioner and an Assistant Oyster Commissioner, whose term of office shall be two years, or until their successors are appointed and qualified. They may be removed by the Governor at any time for cause. The Commissioner shall give bond in the sum of two thousand dollars; the Assistant Commissioner shall give bond in the sum of one thousand dollars. The bonds shall be payable to the State of North Carolina, shall be conditioned for the faithful discharge of their office and the proper accounting for all moneys received, shall have at least two sufficient sureties, and shall be approved by and filed with the Clerk of the Superior Court of the county in which the officer resides and be a part of the records of his office. They shall take and subscribe oaths to support the Constitution and for the faithful performance of the duties of their office, which oaths shall be filed with the bond. The salary of the Commissioner shall be nine hundred dollars per annum, and he shall be allowed three hundred dollars for expenses. The salary of the Assistant Commissioner shall be seven hundred and fifty dollars per annum. The salaries shall be payable monthly.

1903, c. 516.

2404. Inspectors, how appointed; term; salary; bond; oath of office. The Oyster Commissioner shall appoint, from the counties within which they are to perform their duties, a sufficient number of inspectors who shall serve during the oyster season, and may remove them for cause. He shall fix the compensation of the inspectors at not exceeding fifty dollars a month while on duty, and shall designate the length of service, the time when the inspectors go on duty and when they go off. The inspectors shall give bond in the sum of five hundred dollars, payable to the State of North Carolina, conditioned for the performance of the duties of their office and the faithful accounting for all moneys received, which bond shall have at least two sufficient sureties, to be justified before, approved by, and filed with the Clerk of the Superior Court of the county where they reside, and shall take, subscribe, and file with such Clerk an oath of office. They shall be paid only for the time they serve.

1903, c. 516.

2405. Duties of the Oyster Commissioner. The Oyster Commissioner shall have a general supervision over every branch of the oyster industry, and see that the laws regulating the same are rigidly enforced. He shall furnish the inspectors and the Clerks of the Superior Courts of the several counties mentioned in this subchapter such receipt and record books and other kinds of stationery as may be necessary to keep a correct record and account of all the money collected and all information necessary to be kept. Such stationery shall be furnished by the Commissioner of Labor and Printing upon requisition of the Oyster Commissioner.

He shall see that the law regulating the catching and handling of oysters is enforced; that no illegal methods are used in catching, selling, or shipping; that the cull law is rigidly enforced, and that only proper and legal measures are used in buying and selling. He shall prosecute all violations of the law, and whenever it is necessary he may employ counsel for this purpose. He may also employ or charter sail vessels, tugs, and other boats when necessary to the performance of the duties of his office. He shall in his official capacity have power to administer oaths and to send for and examine persons and papers. He shall, on or before the twenty-fifth day of each month, mail to the Treasurer of the State a consolidated statement showing the amount of taxes collected during the preceding month and by and from whom collected. He shall make a biennial report to the Governor, setting forth in detail an account of his official acts, the condition of the oyster industry in all its branches, and shall recommend such additions to or modifications of existing laws relating thereto as he may deem proper and necessary. He shall have power and authority and it shall be his duty to make and prescribe all such reasonable rules and regulations as may be necessary and to carry into effect and operation the laws relative to the oyster industry according to its true intent and purposes.

1903, c. 516, ss. 3, 18.

2406. Duties of the Assistant Commissioner. The Assistant Oyster Commissioner shall be charged with the special supervision, under the Commissioner, of all matters relating to oyster industry in the different counties. He is particularly charged with the rigid enforcement of the cull feature of the law, the provisions against the use of illegal measures in buying or selling, and the unlawful use of scoops, scrapes, and dredges in the bays, creeks, straits, sounds, rivers, and their tributaries, and elsewhere where the same is prohibited.

1903, c. 516, s. 3.

and

2407. Duties of inspectors. The inspectors shall, under the Commissioner and Assistant Commissioner, be charged with all matters relating to the oyster industry in their respective counties; they shall inspect all oysters offered for sale in their county, see that they are properly culled, see that none of the provisions of the law regulating the oyster industry are violated, collect all taxes from dealers on oysters purchased or caught, keep a correct record of all taxes collected by them and from whom and for what purpose collected, and on or before the fifth day of each month mail to the Oyster Commissioner a report, on such form as he may prescribe, showing all taxes collected by them and from whom received, and at the same time pay over to the Commissioner the amount of such taxes.

1903, c. 516, s. 3.

be repealed by the Legislature, provided the organization of the Shellfish Commission as outlined above is passed.

That section

2408. Who may be licensed to catch oysters. No person shall be licensed to catch oysters from the public grounds of the State who is owner, lessee, master, captain, mate, or foreman, or who owns an interest in or who is an

agent for any boat that is used or that may be used in dredging oysters from the public grounds of the State, who is not a *bona fide* resident of this State and who has not continuously resided therein for two years next preceeding the date of his application for license; and no non-resident shall be employed as a laborer on any boat licensed to dredge oysters under this subchapter who has an interest in or who receives any profit from the oysters caught by any boat permitted to dredge oysters on the public grounds of the State. Any person, firm, or corporation employing any non-resident laborer forbidden by this section, upon conviction shall be fined not less than fifty dollars nor more than five hundred dollars.

1903, c. 516, s. 6; 1905, c. 525, s. 3.

remain as it is.

That section

2409. How license obtained to catch oysters; who may issue; form of. Any person desiring to catch oysters from the public grounds and natural oyster-beds shall make and subscribe to the following oath, before some officer qualified to administer oaths:

I,..... (state if owner, lessee, master, captain, mate, foreman, or agent of any boat used or that may be used in dredging oysters from the public grounds of the State), being an applicant for oyster license, do solemnly swear that I am a citizen of North Carolina and have been a resident of the State for the two years next preceding this day; that my place of residence is now in..... county; that I will not, if granted license, employ any non-resident or unlicensed person as an assistant or serve as an assistant to any non-resident who is owner, lessee, master, captain, mate, or foreman, or who has any interest in, or in the profits derived from, any boat that is used or that may be used in dredging oysters from the public grounds of the State, or unlicensed person, nor will I transfer, assign, or otherwise dispose of my license to any person, firm, or corporation; that I will not knowingly or wilfully violate or evade any of the laws or regulations of the State relating to oyster industry: so help me, God.

He shall then present to and file said oath with the Oyster Commissioner, Assistant Oyster Commissioner, or inspector, who, if satisfied with the truth of the statement made in the oath of application, shall issue to him an oysterman's license in the following form:

State of North Carolina, ...County.

....., a resident of county, having this day made application to me for an oysterman's license, and having filed with me the oath prescribed by law, I do hereby grant to him license to catch oysters from the public grounds of this State from the fifteenth day of October, ..., until the first day of next April. Witness my hand and official seal, this the day of, 19....
Oyster Commissioner, Assistant Oyster Commissioner, or inspector (as the case may be).

The said oath and a record of the license shall be kept by the Oyster Commissioner, Assistant Commissioner, or inspector, and for issuing and recording the same he shall receive from the applicant a fee of twenty-five cents, which, together with all other license fees collected under this chapter, shall be paid over to the State Treasurer and constitute part of the oyster fund. No fee shall be charged by the Clerk for administering the oath.

1903, c. 516, s. 7; 1905, c. 525, ss. 4, 6.

NOTE.—For making false affidavit, see Crimes.

be amended so that "a fee of twenty-five cents" shall read "a fee of one dollar."

That section

2410. License for boat used in catching oysters. The Oyster Commissioner, Assistant Oyster Commissioner, or inspector may grant license for a boat to be used in catching oysters, upon application made according to law, and the payment of a license tax as follows: On any boat or vessel without cabin or deck, and under custom-house tonnage, using scoops, scrapes, or dredges, measuring, over all, twenty-five feet and under thirty, a tax of three dollars; fifteen feet and under twenty feet, a tax of two dollars; on any boat or vessel with cabin or deck and under custom-house tonnage, using scrapes or dredges, measuring, over all, thirty feet or under, a tax of five dollars; over thirty feet, a tax of six dollars; on any boat or vessel using scoops, scrapes, or dredges, required to be registered or enrolled in the custom-house, a tax of one dollar and fifty cents a ton on gross tonnage. No vessel propelled by steam, gas, or electricity, and no boat or vessel not the property absolutely of a citizen or citizens of this State on the first day of January, one thousand nine hundred and three, or unless built or owned in this State subsequent thereto and actually owned by a *bona fide* resident of this State under this chapter, shall receive license or be permitted in any manner to engage in the catching of oysters anywhere in the waters of this State. All boats or vessels so licensed to scoop, scrape, or dredge oysters shall display on the port side of the jib, above the reef and bonnet and on the opposite side of mainsail, above all reef points, in black letters not less than twenty inches long, the initial letter of the county granting the license and the number of said license, the number to be painted on canvas and furnished by the Oyster Commissioner, Assistant Oyster Commissioner, or inspector issuing the license, for which he shall receive the sum of fifty cents. Any boat or vessel used in catching oysters without having complied with the provisions of this section may be seized, forfeited, advertised for twenty days at three public places in the county where seized, and sold at some public place designated in the advertisement, and the proceeds paid into the oyster fund.

1903, c. 516, s. 8.

remain as it is.

That section

2411. License to oyster dealers. The Oyster Commissioner, Assistant Oyster Commissioner, or inspector, shall, upon application and the payment of a fee of fifty cents, grant to the applicant a dealer's license, authorizing the applicant to engage in the business of buying, purchasing, canning, packing, shucking, or shipping oysters. Such license shall not be issued prior to the fifteenth day of October of any year and shall expire on the first day of April following. The Assistant Oyster Commissioner or inspector granting the license shall at once mail a duplicate to the Oyster Commissioner.

1903, c. 516, s. 9; 1905, c. 525, s. 6.

remain as it is.

That section

2412. Licenses reported monthly. The Oyster Commissioner, Assistant Oyster Commissioner, or inspector, who are authorized to issue license or to collect a license tax, shall, on or before the fifteenth day of each month, mail

to the Oyster Commissioner a statement showing all licenses issued during the preceding month, to whom issued, and for what purpose, and the amount of tax collected by them from all sources under the oyster laws, and shall at the same time remit said amount direct to the State Treasurer. They shall at the same time mail to each inspector asking for the same a list of all persons to whom license has been issued and of all boats or vessels licensed, and for what purpose.

1903, c. 516, s. 4; 1905, c. 525, s. 6.

remain as it is.

That section

2413. Dredging, when allowed; prohibited territory. Any *bona fide* resident of the State duly licensed according to law and using a licensed boat or vessel may use scoops, scrapes, or dredges in catching or taking oysters from the fifteenth day of November in each year to the first day of April following, from the public grounds and natural oyster beds in the broad open waters of Pamlico Sound, Pamlico River, Neuse River, and Long Shoal River, except in those portions of said sound and rivers in which the use of such instruments and implements is prohibited as herein provided. No person shall use any implement or instrument except hand-tongs in catching oysters in any bay, river, creek, strait, or any tributary of such which border upon or empty into Pamlico Sound, Pamlico River, or Long Shoal River, except as hereinafter provided; and any point inside of a line drawn from the farthest or extreme outward point of land or marsh on the one side to the farthest or extreme outward point of land or marsh on the opposite side of any creek, strait, or bay, shall be construed to be within the said creek, strait, or bay for the purposes of this section. Nor shall any person use any implement or instrument except hand-tongs in the waters of Pamlico Sound from what is known as the Reef or Reefs in the eastern portion of said sound to the line of banks bordering its eastern shores; nor along the shores of Pamlico County inside of a line beginning at Maw Point and running to the west end of Brant Island, thence to Pamlico Point; nor in the waters of Pamlico Sound north of a line running from Long Shoal light to Gull Shoal life-saving station, from the first day of February of each year to the fifteenth day of November, nor in any of the waters of Carteret County. And for the purpose of this section, the northern boundary of said county shall be a line extending from Swan Point to Harbor Island light, thence a line to Southwest Straddle light, thence a line to Northwest Point light, thence a line to the middle of Ocracoke Inlet; nor in the waters of Neuse River above a line in said river running from Carbacon buoy to the western point of land at Pierce's Creek.

1903, c. 516, ss. 13, 14, 15; 1905, c. 507, s. 2.

remain as it is.

That section

2414. Governor may suspend right to dredge. The Governor, upon the request of the Oyster Commissioner, may, whenever in his judgment it is necessary, by proclamation, suspend entirely the use of all scoops, scrapes, or dredges in any of the waters of the State, either for a definite period of time or until the sitting of the next General Assembly.

1903, c. 516, s. 19.

remain as it is.

That section

2415. Oysters culled on grounds. All oysters taken from the public grounds of this State, with whatsoever instrument or implement, shall be culled, and all oysters whose shells measure less than two and one-half inches from hinge to mouth, except such as are attached to a large oyster and cannot be removed without destroying the small oyster, and all shells taken with the said oysters shall be returned to the public ground when and where taken, and no oysters shall be allowed by the inspectors to be marketed which shall consist of more than ten per cent. of such small oysters and shells, except "coon" oysters and oysters largely covered with mussels: *Provided*, these musselled oysters must not contain more than five per cent. of shells or small oysters under regulation size.

1903, c. 516, s. 11; 1905, c. 525.

be amended so that in the third and fourth lines "two and one-half inches from hinge to mouth" shall read "three inches in longest diameter."

That section

2416. Oysters not culled seized and put on public grounds. Whenever oysters are offered for sale or loaded upon any vessel, car, or train, without having been properly culled according to law, the Commissioner, Assistant Commissioner, or inspector shall seize the boat, vessel, car, or train containing the same and shall cause the said oysters to be scattered upon the public grounds, and the costs and expenses of said seizure and transportation shall be a prior lien to all liens on said boat, vessel, car, or train, and if not paid on demand the officers making the seizure shall, after advertisement for twenty days, sell the same and make title to the purchaser, and after paying expenses as aforesaid pay the balance, if any, into the oyster fund.

1903, c. 516, s. 3.

NOTE.—For selling uncultured oysters, see s. 2392.

be repealed, as amended Section 2393 includes this.

That section

2417. Dimensions of oyster measure. All oysters measured in the shell shall be measured in a circular tub with straight sides and straight solid bottom, with holes in the bottom, not more than one-half inch in diameter. The said measure shall have the following dimensions: A bushel tub shall measure eighteen inches from inside to inside across the top, sixteen inches from inside to inside chimb to the bottom, and twenty-one inches diagonal from inside chimb to top. All measures used for buying or selling oysters shall have a brand, to be adopted by the Oyster Commissioner, stamped therein by said Commissioner, Assistant Commissioner, or his lawful inspectors. All measures found in the

possession of any dealer not meeting the requirements of this section shall be destroyed by said Oyster Commissioner, Assistant Commissioner, or inspector.

1903, c. 516, s. 12.

be amended by inserting in fourth line, after "half inch in diameter," the words "or provided with opening one-half inch in width from bottom chimb around bottom of tub."

That section

2418. Dealers to keep records. All persons engaged in buying, packing, canning, shucking, or shipping oysters shall keep a permanent record of all oysters either bought or caught by them, or by persons for them, when and from whom bought, the number of bushels and the price paid therefor. All these records shall at all times be open to the examination and inspection of the Oyster Commissioner, Assistant Oyster Commissioner, and inspector, and upon request shall be verified by the parties making them.

1903, c. 516, s. 5.

remain as it is.

That section

2419. Purchase tax. All dealers in oysters and all persons who purchase oysters for canning, packing, shucking, or shipping shall pay a tax of one and one-half cents on every bushel of oysters purchased by them, or caught by them, or any one for them: *Provided*, that "coon" oysters shall be taxed one-half a cent a bushel only; and no oysters shall be twice taxed. This tax shall be paid to and collected by the inspectors, and when paid a receipt shall be given therefor. Upon failure or refusal by any person, firm, or corporation to pay said tax, his license as a dealer shall at once become null and void, and no further license shall be granted him during the current year, and it shall be the duty of the Commissioner, Assistant Commissioner, or inspector to institute suit for the collection of said tax. Such suit shall be in the name of the State of North Carolina on relation of the Commissioner or of the inspector at whose instance such suit is instituted, and the recovery shall be for the benefit and to the use of the general oyster fund.

1903, c. 516, s. 10; 1905, c. 507.

remain as it is.

That section

2420. Vessels with oysters, when allowed to go through canals. No boat or vessel loaded with oysters shall be permitted by the inspectors of South Mills and Coinjock to pass through the canals, which do not have a certificate showing that the cargo has been inspected and the tax paid thereon.

1903, c. 516, s. 17.

be amended so as to read:

No boat or vessel loaded with shell-oysters, except those in barrels, shall be permitted by the inspectors of South Mills and Coinjock to pass through the canals.

That section

2421. Shells scattered on oyster beds, The Oyster Commissioner is hereby empowered to expend one-half of the balance to the credit of the oyster fund on the fifteenth day of April in each year for the purpose of buying oyster shells and scattering the same on the natural oyster grounds of the State during the months of April and May.

1903, c. 516, s. 20.

remain as it is.

That section

2422. Oyster funds kept separate, how paid out. The Treasurer of the State shall keep all funds derived from the oyster industry separate and apart from other funds in the treasury and shall pay the same out only upon the warrant of the Auditor, and the Auditor shall issue no warrant on said fund in payment of any claim unless the same shall have been first approved by the Oyster Commissioner.

1903, c. 516, s. 20.

be repealed if the new legislation regarding the Shell-fish Commission is passed.

That section

2426. Catching oysters in Myrtle Grove Sound. If any person shall take or catch any oysters from Myrtle Grove Sound, from Perrines or Whitaker's Creek to the headwaters of said sound in New Hanover County, from the first day of May until the first day of September, except for his own consumption, he shall be guilty of a misdemeanor, and fined not more than fifty dollars or imprisoned not more than twenty days.

Code, s. 3423; 1883, c. 358, ss. 1, 2.

be repealed.

CLAMS.

That section

2423. Clams. If any person between the first day of April and the first day of November of any year shall take any clams from the waters of Brunswick, New Hanover, or Pender counties for the purpose of shipping, selling, marketing, or for bedding or pounding the same in any artificial bed, or if any person shall take or catch any oysters in the waters of Carteret County by dredging or scoops, or in any manner other than with the ordinary clam rake, or tongs, or if any non-resident shall take or catch any clams, he shall be guilty of a misdemeanor.

1901, c. 113; 1897, c. 333; 1899, c. 579; 1903, cc. 131, 414, 658, 732.

be amended by substituting in the fifth line and all that comes after from "or for bedding * * * of a misdemeanor," the following: "or if any person between the fifteenth day of May and first day of October of any year shall take any clams from the waters of Carteret

County for the purpose of shipping, selling, marketing, or pounding, provided this shall be permitted for the purpose of bedding the same, either on a natural or cultivated bed within the jurisdiction of North Carolina: *Provided*, that in Newport River no clams whatsoever shall be taken from May fifteenth to October first; and, *Provided*, also, that no clams whatsoever are to be taken, shipped, sold, or marketed during the month of August; shall be guilty of a misdemeanor and be fined fifty dollars or imprisoned thirty days in jail.

CULTIVATION OF THE OYSTER AND CLAM.

The following legislation is recommended by the committee as being the most practicable for encouraging and stimulating oyster and clam culture in North Carolina:

Section Shell-fish Commissioner can lease bottoms. The Shell-fish Commissioner shall have power to lease to any duly qualified person, firm, or corporation, for purposes of oyster or clam culture, any bottom of the waters of the State not a natural oyster-bed as defined in this act, nor a clam reservation as defined in this act, in accordance with the provisions of this law.

Section Leasing of bottoms. Any citizen of North Carolina or firm or corporation organized under the laws of the State and doing business within its limits shall be granted the privilege of taking up bottoms for purposes of oyster or clam culture under the provisions of this act of an area not less than one acre nor more than fifty acres, with the exception of the open waters of Pamlico Sound (and for the purposes of this act open waters of Pamlico Sound shall mean the waters that are outside of two miles of the shore line), in which the minimum limit shall be five acres and the maximum shall be two hundred acres: *Provided*, that the limit of entry in Core Sound, North River, Newport River, Bogue Sound, and all bays and creeks bordering on these waters, and in Jones Bay, Rose Bay, Abels Bay, Swan Quarter Bay, Middle Bay, Bay River, Deep Bay, Juniper Bay, West and East Bluff Bays, Wysocking Bay, Fire Creek, Stumpy Point Bay, Mouse Harbor Bay, Maw Bay, and Broad Creek tributaries of Pamlico Sound, shall be one acre as a minimum and ten acres as a maximum: *Provided further*, however, that at the end of one year from the passage of this act that the minimum area in Core Sound, North River, Newport River, Bogue Sound, and all bays and creeks bordering on these waters, and in Jones Bay, Rose

Bay, Abels Bay, Swan Quarter Bay, Middle Bay, Bay River, Deep Bay, Juniper Bay, West and East Bluff Bays, Wysocking Bay, Fire Creek, Stumpy Point, Mouse Harbor Bay, and Maw Bay, and Broad Creek tributaries of Pamlico Sound, shall be one acre and the maximum fifty acres; but no person, firm, corporation, or association shall severally or collectively hold any interest in any lease or leases aggregating an area of greater than fifty acres, except in the open waters of Pamlico Sound, where the aggregate area shall be two hundred acres.

Section Lease, how obtained. Such persons, firms, or corporations desiring to avail themselves of the privileges of this act shall make written application on a form to be prepared by the Shell-fish Commissioner, setting forth the name and address of the applicant, describing as definitely as may be the location and extent of the bottom for which application is made, and requesting the survey and leasing to the applicant of said bottom. As soon as possible after the application is received the Shell-fish Commissioner shall cause to be made a survey and map of said bottom at the expense of the applicant. The Shell-fish Commissioner shall also thoroughly examine said bottoms by sounding and by dragging thereover a chain to detect the presence of natural oysters. Should any natural oysters be found, the Commissioner shall cause examination to be made to ascertain the area and density of oysters on said bottom or bed to determine whether the same is a natural bed under the definition contained in this act. He shall be assisted in this examination on tonging ground by an expert tonger to be appointed by the Board of County Commissioners of the county in which said bottom or the greater portion thereof is located, and the question as to whether the oyster growth is sufficiently dense to fall within the definition of the natural bed shall be determined by the quantity of oysters which the said expert tonger may be able to take in a specified time; and on dredging-ground the Commissioner shall be assisted by an expert dredger, appointed by the Board of County Commissioners of the county in which said bottom or the greater portion thereof is located, and the question as to whether the oyster growth is sufficiently dense to fall within the definition of the natural bed shall be determined by the quantity of oysters which the said expert dredger may be able to take in a specified time. The Shell-fish Commissioner shall require the bodies of bottoms applied for to be as compact as possible, taking into consideration the shape of the body of water and the

consistency of the bottom. No application shall be entertained nor lease granted for a piece of bottom within two hundred yards of a known natural bottom, bed, or reef. A deposit of ten dollars will be required of each applicant at the time of making his application, said sum to be credited to the cost of the survey of the bottom applied for.

Section Marking and staking of leased bottoms. Immediately upon the completion of the survey and the mapping thereof and the payment by the applicant of the cost of said survey and map, the Shell-fish Commissioner shall execute to the applicant, upon a form approved by the Attorney-General of the State, a lease for the bottoms applied for. A copy of the lease, map of the survey, and a description of the bottom, defining its position, shall be filed in the office of the Shell-fish Commissioner. After the execution of said lease, the lessee shall have the sole right and use of said bottoms, and all shells, oysters, and cultch thereon, or placed thereon, shall be his exclusive property so long as he complies with the provisions of this law. The lessee shall stake off and mark the bottoms leased in the manner prescribed by the Shell-fish Commissioner, and failure to do so within a period of thirty days of an order so to do issued by the Commissioner shall subject said lessee to a fine of five dollars per acre for each sixty days' default in compliance with said order. The corner stakes, at least, of each lease shall be marked with signs plainly displaying the number of the lease and the name of the lessee. The lessee shall within two years of the commencement of his lease have planted upon his holdings a quantity of shells equal to an average of fifty bushels of seed oysters or shells per acre of holdings, and within four years from the commencement of his lease, a quantity of oysters or shells equal to an average of not less than one hundred and twenty-five bushels per acre. The Oyster Commissioner shall, upon granting any lease, publish a notice of the granting of same in a newspaper of general circulation in the county wherein the bottom leased is located.

Section Term of lease, rental. All leases made under the provisions of this act shall begin upon the issuance of the lease and shall expire on the first day of April of the twentieth year thereafter. The rental shall be at the rate of one dollar per acre per year for the first ten years and two dollars per acre per year for the next ten years of the lease, payable annually in advance on the first day of April of each year: *Provided*, that in the open waters of Pamlico Sound—

and for the purposes of this act the open waters of Pamlico Sound shall mean the waters that are outside the two miles of the shore line—the rental shall be at the rate of fifty cents per acre per year for the first three years; one dollar per acre per year for the next seven years; and two dollars per acre per year for the next ten years of the lease. This rental shall be in lieu of all other taxes and imposts whatever and shall be considered as all and the only taxation which can be imposed by the State, counties, municipalities, or other subordinate political bodies. The rental for the first year shall be paid in advance to an amount proportional to the unexpired part of the year to the first of April next succeeding.

Section Transfer of lease, inheritance of lease. The said lease shall be heritable and transferable, in whole or in part, provided the qualifications of the heirs and transferees are such as are described by this act. Non-residents acquiring by inheritance or process sale, or persons already holding the maximum area permitted by this act, shall within a period of twelve months from time of acquisition dispose of said prohibited or excess of holding to some qualified person, firm, or corporation, under penalty of forfeiture. The lease shall be subject to mortgage, pledge, seizure for debt, and the same other transactions as are other property rights in North Carolina. No transfer shall be of effect, unless of court record, until entered on the books of the Shell-fish Commissioner.

Section Re-leasing of bottoms. The term of each lease granted under the provision of this act shall be for a period of twenty years from the first day of April preceding the date of granting of said lease. At the expiration of the first lease the lessee, upon making written application on the prescribed form, shall be entitled to successive leases on the same terms as applied to the last ten years of the first lease, for a period not exceeding ten years each.

Section Forfeiture of lease. The failure to pay the rental of bottoms leased for each year in advance on or before the first day of April or within thirty days thereafter shall *ipso facto* cancel said lease and shall forfeit to the State the said leased bottoms and all oysters thereon, and upon said forfeiture the Shell-fish Commissioner is hereby authorized to lease the said bottoms to any qualified applicant therefor: *Provided*, that no forfeiture shall be valid, however, under the provisions of this section, unless there shall have been

mailed by the Shell-fish Commissioner to the last address of the lessee upon the books of the Commissioner a thirty days' notice of the maturity of said rental.

Section Title secure. If any person within four months of the publication of the notice of granting of any lease make claim that a natural oyster bottom, bed, or reef exists within the boundaries of said lease, he shall under oath state his claim and request the Shell-fish Commissioner to cancel said lease: *Provided, however,* that each such claim and petition shall be accompanied by a deposit of twenty-five dollars. No petition unaccompanied by said deposit shall be considered by the Commissioner. The Shell-fish Commissioner shall in person examine into said claim, and if the decision should be against the claimant, the deposit of twenty-five dollars shall be forfeited to the State and deposited to the credit of the Shell-fish Commission fund. Should, however, the claim be sustained and a natural bed be found within the boundary of the lease, the said natural bed shall be surveyed and marked with stakes or buoys at the expense of the lessee, and the said natural bed be thrown open to the public fishery. If no such claim be presented within a period of four months, or if when so presented it fail of substantiation as provided, the lessee shall thereafter be secure from attack on such account and his lease shall be incontestable so long as he complies with the other provisions of this act. In each and every such case the decision of the Shell-fish Commissioner shall be subject to review and appeal before a Judge of the Superior Court, who shall render a decision without the aid of a jury, and his decision shall be final.

GENERAL SHELL-FISH LAWS.

Section The State of North Carolina shall exercise exclusive jurisdiction and control over all the shell-fisheries of the State wherever located, whether these fisheries be for oysters, clams, scallops, or any other mollusca whatever.

Section All these acts relating to the fish, oyster, and clam are to be effective as soon as they have been ratified.

Section Delivery of oysters without inspection. If any boatman shall deliver oysters to any one before they have been inspected by the inspector, he shall be guilty of a misdemeanor, and fined not less than fifty dollars: *Provided,* that in case the boatman

is unable to find the inspector, he (the boatman) can deliver the oysters and report to the inspector afterwards, but within forty-eight hours of delivery of oysters.

If the act creating the Shell-fish Commission is passed by the Legislature, then all reference to Oyster Commissioner or Deputy Oyster Commissioner in any act shall be changed to read Shell-fish Commissioner and Deputy Shell-fish Commissioner respectively.

The above recommendations are respectfully submitted by the committee.

J. J. LAUGHINGHOUSE,
M. B. GOWDY,
J. B. COFFIELD,
W. O. LUPTON,
T. H. SHEPARD,
W. A. SAUNDERS,
W. E. SWINDELL,
H. F. MOORE,
W. M. WEBB,
R. W. SMITH, *Secretary*.
JOSEPH HYDE PRATT,
Chairman.

[LETTER OF ENDORSEMENT.]

Department of Commerce and Labor

BUREAU OF FISHERIES

Washington

October 27, 1906.

DR. JOSEPH HYDE PRATT,

*Chairman Committee on Fisheries of North Carolina,
Chapel Hill, N. C.*

SIR:

The preliminary draft of the report and recommendations of the committee appointed by the Governor of North Carolina to consider the legislative requirements of the oyster and fishery industries of that State has been received and examined at this office. The experience of this Bureau in its fish-cultural operations and in the numerous investigations of various character which it has conducted from time to time in the waters of North Carolina has impressed it with the imperative need of a thorough revision and enforcement of the laws relating to the fisheries in general, but especially those applying to shad and oysters. During the past ten years this Bureau has expended many thousands of dollars in the hatching of shad in the waters of North Carolina, and during that period has planted about two hundred million fry, most of which were derived from without the State, the local yield of eggs being insufficient for requirements. The magnitude of this work and its measure of success depend upon the number of ripe fish reaching the spawning-grounds during the season in which the physical conditions of the rivers are favorable to the maturation and development of the eggs. The spawning-grounds are all in the upper waters and the fish will not ripen in the saline water of the sounds. The fish caught on or near the natural spawning-grounds are in large part utilized in the fish-cultural operations of this Bureau, but those taken in the lower sounds are an absolute loss reproductively. It would be an injustice, however, to prohibit or unduly restrict the fisheries in the sounds, and such interference with a valuable and legitimate industry is entirely foreign and antagonistic to the purposes of this Bureau; but it is believed that the very existence of the shad fisheries in both the sounds and the rivers depends upon permitting a proper proportion of mature fish to ascend the streams. Under the regulations until recently in force this essential was impossible of realization. Not only has the amount of apparatus fished been in excess of that which the reproductive capacity of the several species would permit, but the nets have been set in such manner and in such places that access to the spawning-grounds was in large measure prevented, and the fish were either caught before they were ripe or were retarded and held in the sounds until the season had passed when the process of reproduction could be successfully performed. The Bureau observes with satisfaction that these matters were given careful consideration by the committee, and that especially in the proposed modification of the Vann law and the restriction of the open seasons to conform with local requirements an attempt was made to give access to the spawning-grounds to a larger proportion of the fish coming from the sea. The Bureau's representative on the committee has made certain verbal changes in the rough draft, which, it is believed, make clearer and more specific the intent of the board, and with these changes the

articles referred to are regarded with approval. Were there no established fisheries in the lower sounds, somewhat more rigorous restrictions might be advocated; but those persons already engaged in the industry are entitled to consideration and their interests should be protected so far as is compatible with the perpetuation of the fisheries. The amount of apparatus now in use should be regarded as the approximate maximum for some years to come, and any increase over that employed in the spring of 1906 should be regarded as inimical to the best interests of the State. The recommendations concerning the appointment of a Fish Commissioner, charged specifically with the execution of the fishery laws, are strictly in accord with previous recommendations of this Bureau. It is essential for the proper execution of the laws, the guidance of future legislation, and the investigation of the many problems relating to the fisheries, that there should be a definite organization for the purpose, and as divided or local jurisdiction over the fisheries has never been satisfactory, this organization should operate under the general authority of the State. Should the recommendations be enacted into law, it is believed that the State will soon feel the benefit.

No less important is the proposed reorganization of the Oyster Commission and its functions, and the new laws and amendments recommended meet with the hearty endorsement of this Bureau. The oyster industry of the State can never reach its legitimate development, except through the enactment and rigorous enforcement of laws protecting the public oyster-beds and establishing private oyster culture upon a secure foundation, the two purposes being in no manner antagonistic, but rather mutually dependent. The recommendations proposed by the Board appear to cover the requirements. The natural beds are protected on the one hand from injudicious and destructive methods of oystering, and on the other are preserved inviolate from private acquisition and maintained forever as a common possession for all citizens of the State who may comply with reasonable regulations. The provisions relating to oyster culture permit the leasing under reasonably generous conditions of otherwise unproductive and useless bottom, and they establish in a satisfactory manner the secure tenure of the leases so granted, while excluding private entry upon bottom which should of right be a common fishery. The matter of a secure tenure of the leaseholds is essential to the success of any attempt to inaugurate oyster culture in the State, and should be jealously safeguarded. The Bureau recommends the enactment of the oyster laws substantially as set forth in the report and believes that such action will result in material financial benefit to the State and its citizens.

While there are some minor features and inconsistencies in the recommendations, to which exception might be taken, especially in those relating to the fisheries proper, the Bureau strongly recommends the passage of laws in general conformance with the report. The committee represented many conflicting interests, all worthy of consideration, and its recommendations should be considered collectively rather than severally and as embodying those suggestions which if put in effect would do most good and least harm to the general interests of the State. Any material departure from the lines laid down by the committee may precipitate a conflict of interests which would destroy the harmonious understanding which the appointment of the board was designed to bring about.

It is apparent from the report that the committee did not consider it its function to go into the details of law-making, and in recommending new legislation and the retention, repeal, and modification of old laws, there are naturally some inconsistencies, duplications and contradictions. In the interests of clear-

ness and brevity, the Bureau trusts that the report will be placed in competent hands, that a general or codified law may be drawn covering the recommendations made and repealing such acts or parts of acts as may be in conflict therewith.

The Bureau will watch with interest the progress of this effort to provide more satisfactory fishery laws in North Carolina, and stands ready to co-operate in furtherance of the work of your committee.

Respectfully,

H. M. SMITH,
Acting Commissioner.



PUBLICATIONS
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BULLETINS.

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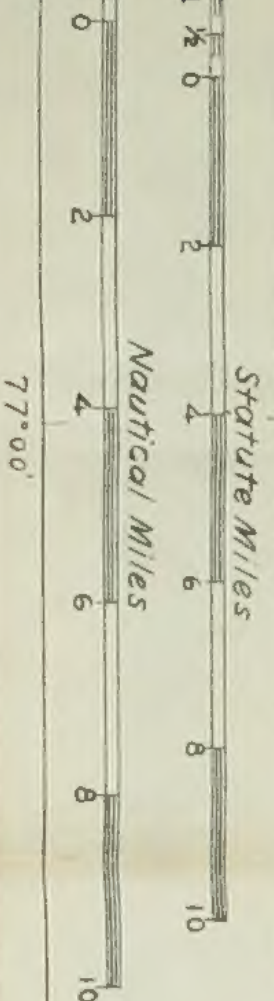
- Vol. 1. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 50 cents extra.*
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Map showing
approximate location of seines
and pound nets fished for shad
in 1906.

U.S. Bureau of Fisheries.

Reduced from U.S.C. & G.S. Charts
Nos. 144, 144²



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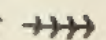
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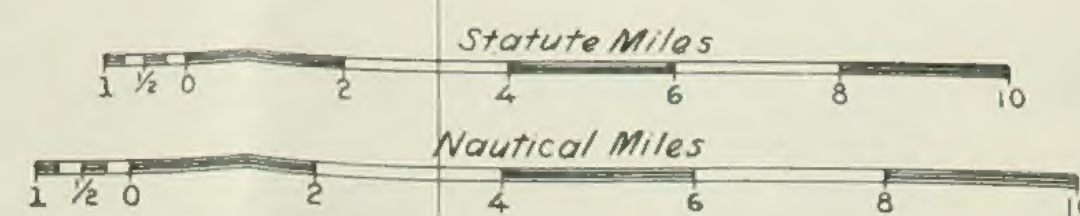
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Note
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Map showing
 approximate location of seines
 and pound nets fished for shad
 in 1906.

U.S. Bureau of Fisheries
 Reduced from U.S.C. & G.S. Charts
 Nos. 142, 143.



THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

Economic Paper No. 14

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1906

BY

JOSEPH HYDE PRATT, PH.D.



RALEIGH:

E. M. UZZELL & Co., STATE PRINTERS AND BINDERS.

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LETTER OF TRANSMITTAL.

CHAPEL HILL, N. C., August 1, 1907.

To His Excellency, HON. ROBERT B. GLENN,

Governor of North Carolina.

SIR:—I herewith have the honor to submit for publication, as Economic Paper No. 14, a Report on the Mining Industry in North Carolina for the Year 1906. This report takes up especially a description of all the producing gold mines, and a general discussion of the occurrence of mica.

Yours respectfully,

JOSEPH HYDE PRATT,

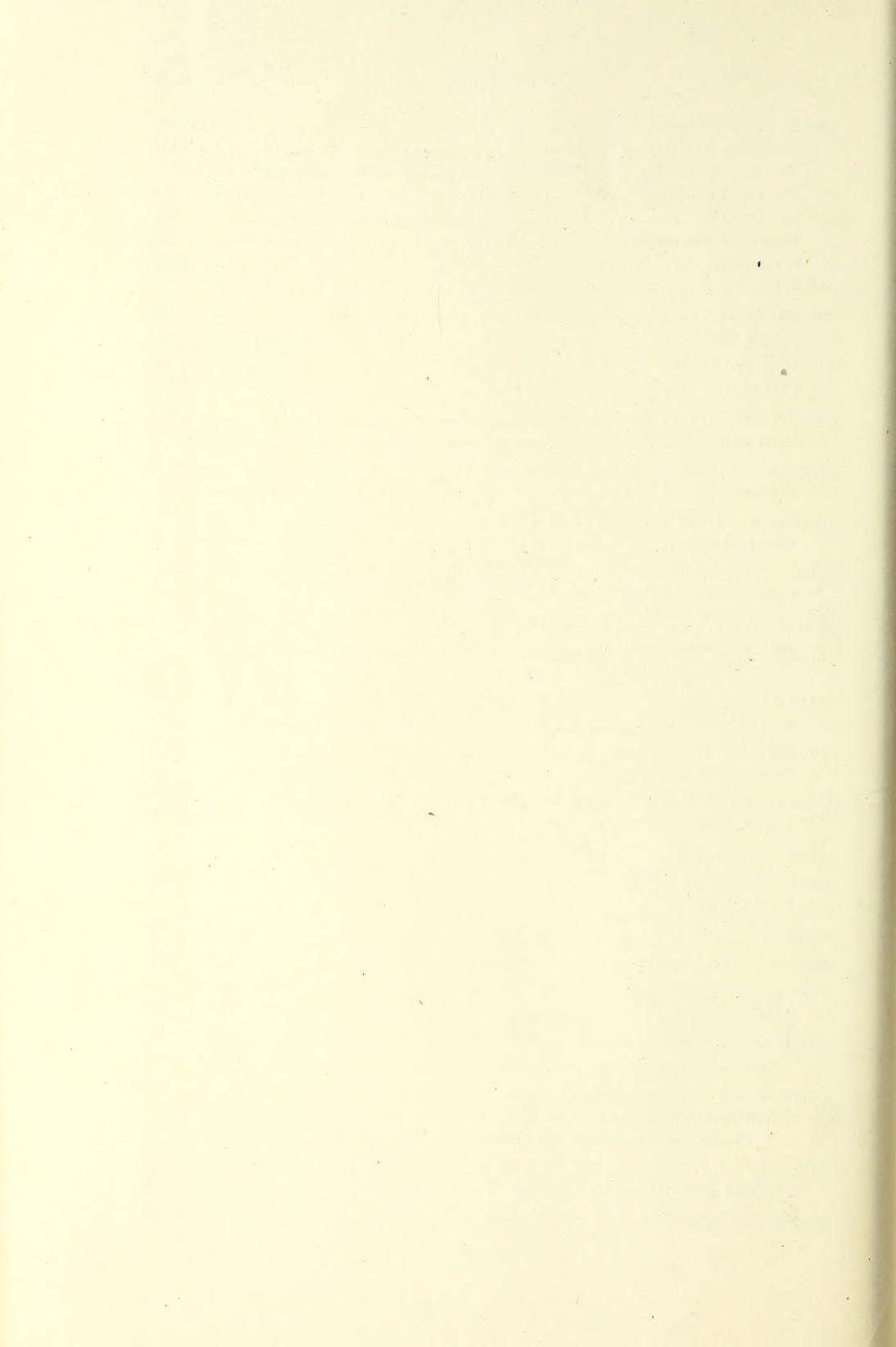
State Geologist.

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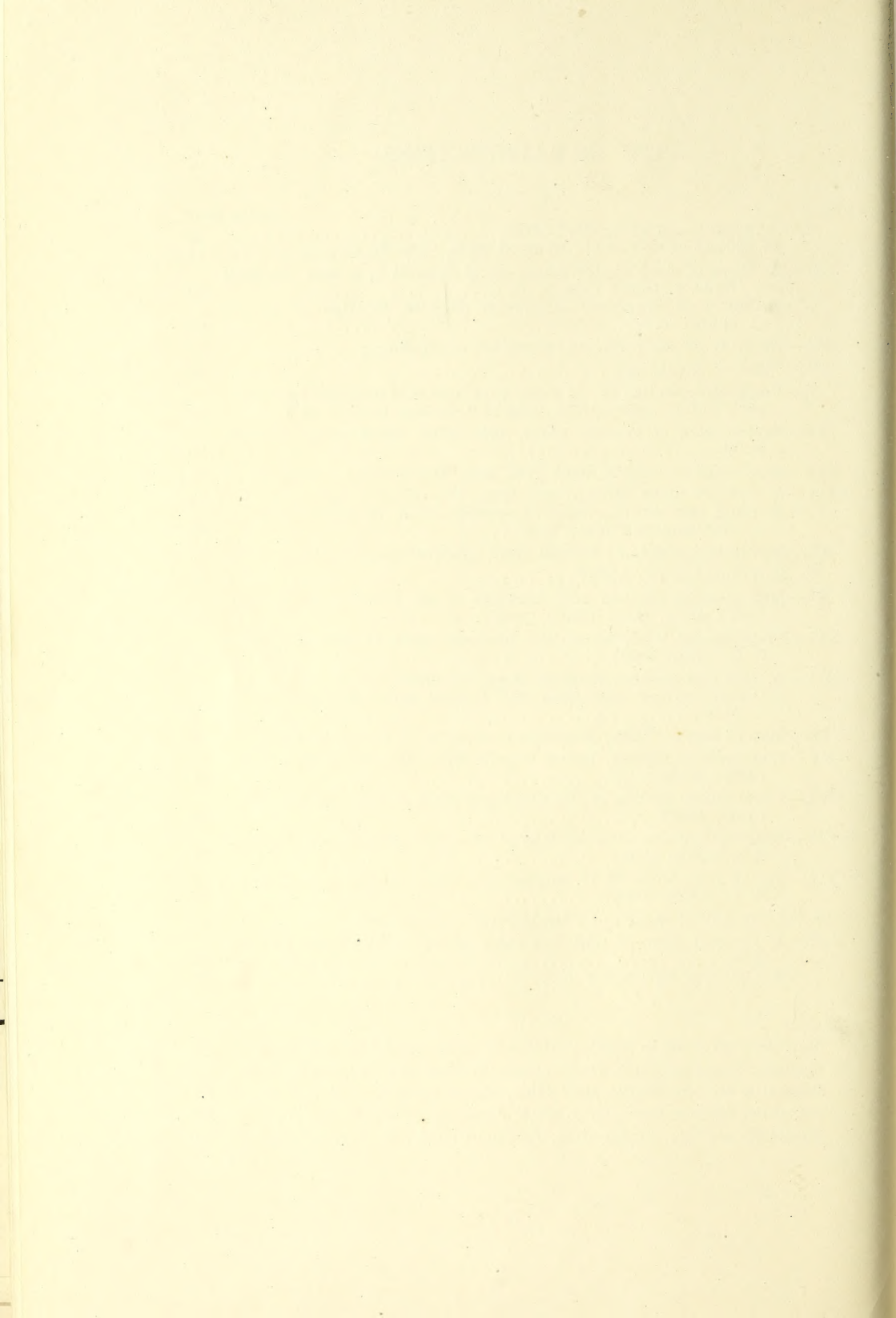
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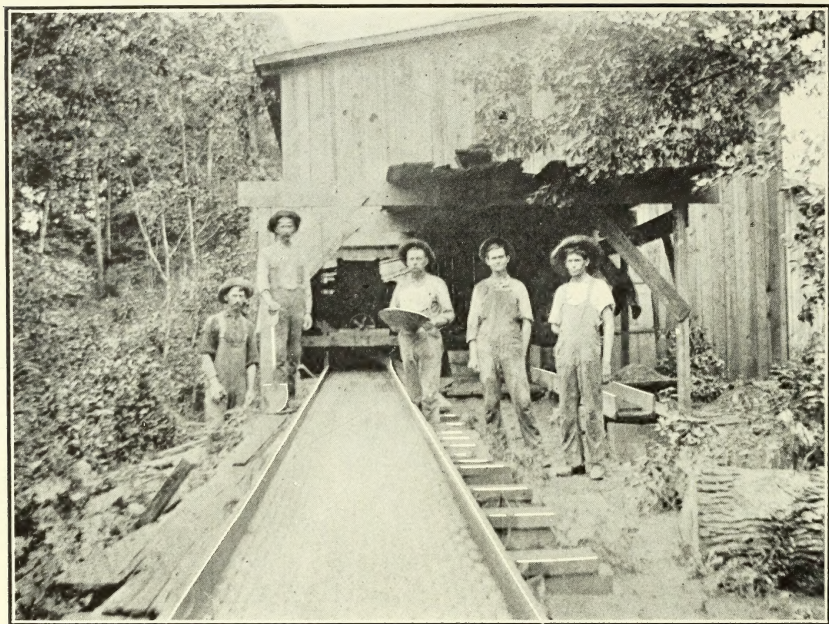
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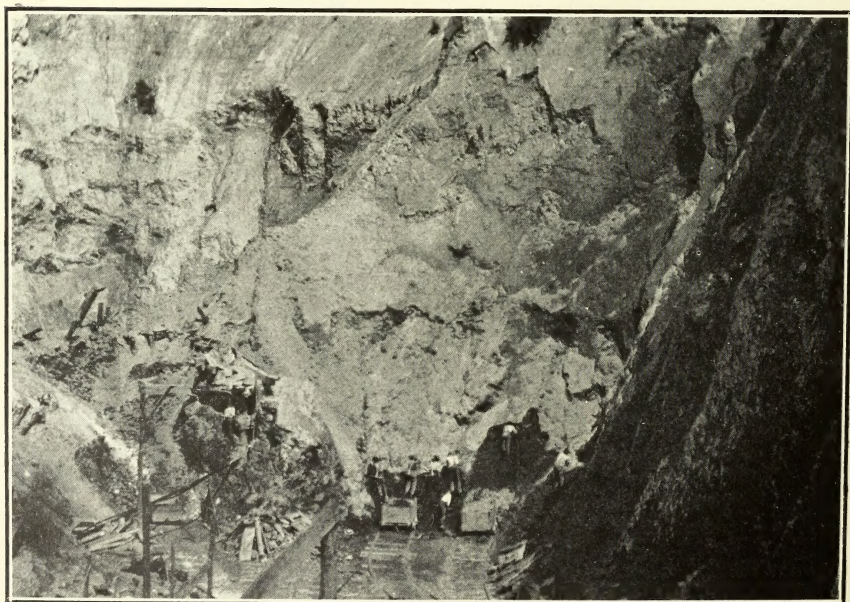
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A. RIFFLE BOARD AT SHUFORD MINE.



B. BOTTOM OF 90-FOOT PIT, SHUFORD MINE, CATAWBA COUNTY, N. C.

MINING INDUSTRY IN NORTH CAROLINA DURING 1906.

BY JOSEPH HYDE PRATT.

INTRODUCTION.

During the past year, 1906, there has continued to be an increase in the production of those minerals which constitute North Carolina's chief mineral resources in that they offer greater possibilities for investment in the State. The production of building stones and clay products was very largely in excess of that of the previous year and is partly due to the unprecedented amount of construction work that has been done throughout the country during 1906. There is also a marked increase in the production of mica, monazite and copper. It will be noted that North Carolina's chief mineral products are the nonmetallic minerals, and that in the production of the heavy metals, such as gold, silver and copper, North Carolina does not play a very important part at the present time in the total production of these metals in the United States. During 1905 and 1906 a systematic investigation was made of the gold mines of the State and especial attention was given to the operating mines. A close study was made of mining methods and a detailed description of this investigation is given in this report under the head of Gold and Silver.

A similar investigation is now being made of the copper deposits of the State and this will be published in the report on the Mining Industry for 1907.

Considered as a whole, the mining and quarrying industries of the State are in a more prosperous and flourishing condition than ever before in the history of the State, and this condition means a greater activity in mining and a larger investment in the mineral resources of the State. Those minerals offering promising fields of investment are being exhibited at the Jamestown Exposition and the whole of the State's mineral exhibit is emphasizing the value of her commercial mineral resources.

During 1906 the total value of the mineral production of North Carolina* was \$3,007,601, as compared with \$2,439,381 in 1905, an increase of \$568,220. The production of 1905 was an increase of \$493,108 as compared with \$1,946,273, the value of the 1904 production. There is given in the following table the value of the various minerals produced in North Carolina for the years 1901 to 1906 inclusive. This table shows strikingly the general increase of North Carolina's mineral production and emphasizes particularly the increase in the value of the production of those minerals in which North Carolina excels.

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS 1901-1906.

Mineral.	Value.					
	1901.	1902.	1903.	1904.	1905.	1906.
Gold -----	\$ 60,411	\$ 93,650	\$ 113,604	\$ 123,924	\$ 129,153	\$ 122,008
Silver -----	34,024	30,212	16,907	19,132	20,216	30,944
Copper -----	76,900	212,553	67,037	36,600	88,000	135,829
Iron -----	4,997	52,771	78,540	79,846	70,352	75,638
Pyrite -----	32,000					
Garnet -----	43,000	10,040				
Corundum -----	48,840		12,250	6,586	9,000	
Millstones -----		1,425	902	6,500	2,652	4,110
Mica { Sheet -----	79,849	81,653	86,300	100,724	100,900	205,756
{ Scrap -----	14,200	2,919	2,400	3,410	3,375	11,940
Quartz -----	7,500	11,250	36,827	36,269	13,659	12,578
Precious stones -----	24,245	5,300	1,525	10,600	3,350	5,000
Rare minerals -----		60	270	160		
Monazite -----	59,262	64,160	58,694	79,438	107,324	125,510
Zircon -----		360	570	200	1,600	248
Barytes -----	22,615	44,130	21,347	33,930	21,670	10,020
Talc and pyrophyllite -----	77,974	88,962	76,984	65,483	74,940	66,979
Mineral water -----	42,167	18,795	13,085	21,902	38,755	31,413
Graphite -----	559	4,300	248	525	475	475
Coal -----	5,585	24,500	25,300	8,820	2,336	
Stone -----	284,744	366,727	360,322	312,576	597,922	854,301
Sand and gravel -----					547	9,191
Sand-lime brick -----				17,500	29,103	32,975
Kaolin -----	119,172	108,105	76,000	76,670	85,622	90,036
Clay products -----	788,618	800,000	866,458	944,880	1,038,430	1,182,660
Total value -----	1,821,276	2,021,872	1,915,570	1,985,675	2,439,381	3,007,601

The minerals and ores that have been mined in North Carolina during 1905 are discussed in this report in the following order: Gold and Silver; Copper; Iron; Tin; Abrasive Materials (Corundum, Garnet and Millstones); Mica; Quartz (Flint); Barytes; Monazite and Zircon; Talc and Soapstone; Precious Stones; Mineral Waters; Graphite; Coal; Peat; Stone (Granite, Sandstone, Marble and Limestone); Sand and Gravel; Sand-lime Brick; Kaolin and Clay Products, and Black Sands.

*In the collection of the statistics of the production of the various minerals, the State Survey has had the co-operation of the Department of Mineral Resources of the U. S. Geological Survey.

GOLD AND SILVER.

During the summer of 1906 most of the producing mines were visited by Mr. A. A. Steel and the State Geologist, and there are given beyond descriptions of the conditions found at these various properties.

Many of the causes of failure in North Carolina gold mining can be traced to the lack of adequate capital, which prevents mining from being conducted in the most economic manner. One of the most noticeable of these is the tendency to sink the shafts but 15 to 30 feet before driving a new level and then stoping out a small block of ground instead of having the levels from 75 to 100 feet apart. Since a ton of ore removed in driving the level even in a wide vein will cost fully twice as much as a ton of ore removed by stoping, it is obviously more economical to have as few levels as possible. It becomes difficult to make the raises more than 100 feet and it is expensive to get men and timbers into much higher stopes; therefore, the levels should not be more than 100 feet apart. In a narrow vein where much waste could be left in a stope, the economy is greater, but the ore-shoots may be too uncertain to warrant so great a distance between levels. Somewhat similar to this is the habit of sinking a number of shafts close together instead of only one or two on a vein. This is not so bad for working ore near the surface, but becomes very expensive as the mine gets deeper, especially when hoisting machinery is required on each shaft. This is partially explained by the fact that many of the old mines have been worked at very irregular intervals and the old shafts have become caved in during the period of idleness.

Even those mines having capital are often badly managed. They frequently put in machinery of unnecessarily large capacity, not realizing that a very small engine and bucket can easily get out 10 or 15 tons of ore per day and keep a five-stamp mill busy. There are many small mines that could pay a profit under careful management with only five stamps running for one shift; and some of them have engines big enough to hoist four times as much ore. Since the engineer and top men must be there all the time, there is no economy in operation, but may even be a loss, since the engine cannot work steadily and fuel is wasted keeping up a big fire; and, of course, the first cost is greater. If the mine ever gets much too big for the small engine, it can be used in prospecting or underground work.

A great many shafts are much too large and it is not uncommon to see a little bucket, 30 inches across, dangling in the middle of a hoisting compartment 6 feet square in the clear. It is considerably cheaper to sink a shaft with compartments only 4 feet square in the clear, and when the hoisting compartment is smoothly lined with plank (to assist the ventilation), or fitted with guides, it has just as great a capacity—usually more than enough for the output of the mine. If necessary, the hoisting capacity of a shaft may be greatly increased at any time by putting in a tall bucket, or better, a self-dumping skip and a high speed engine. The ladder and pipe compartment is often as big as 6 by 8 feet. Since the cheaper and better direct acting steam pump would now be placed in a shaft, instead of the bulky Cornish pump, the water, steam and compressed air pipes take up very little room. It is now customary to put in slanting ladders between landings some distance apart. They can almost as well be a little steeper and shorter and go in a smaller space. The men will always ride up in a bucket, fitted with a crosshead running in proper guides, or running in a closely planked compartment, if the shaft is crooked. Therefore, the ladder-way is an emergency exit only and a good, continuous vertical ladder securely fastened against one wall of the compartment is all that is needed, and the compartment for ladder and pipes may seldom need be over 3 by 4 feet. The two compartments and the division between them then need be only 4 by 8 or $3\frac{1}{2}$ by 7 feet inside. Besides being much more cheaply and rapidly sunk, the small shaft need not be so heavily timbered, since the shorter timbers are stronger and the earth pressure tends to arch around the shaft instead of coming full upon the timbers. On the other hand, the first 6 by 10 feet ($8\frac{1}{2}$ by $12\frac{1}{2}$ feet, outside timbers) shaft at the Montgomery Mine, at Candor, Montgomery County, became useless after about 5 years from the buckling of the timbers, although splendidly timbered with 12 by 12 inch oak sets, showing no signs of decay.

There is, of course, very seldom any need for more than one hoisting compartment, since the saving in power will only pay for the greater expense of engine and shaft when a large amount of ore is to be hoisted from considerable depth. When a single large skip will handle all the ore, there is no need of putting in another to remain idle half the time.

Timber framing for shafts and tunnel sets is often unnecessarily complicated and the carpenter must waste much time chiselling, when simple notches laid off with a square and cut by saws are often stronger and always more easily made.

The most disastrous error is usually great haste in installing a mill or smelter. It seems that the first thing that many miners think of after finding a little good ore is to stop work in the mine and put up a mill; and thus there are some mills which have been able to run less than a month before the mine was exhausted. There is usually a neighboring mill to which the ore might as well have been hauled. It is seldom that tests are made to tell what sort of a mill and treatment is adapted to the ore. Unless the ore body is large, no mill should be installed until the changed ore below water level has been tested.

In North Carolina there seem to be only a few miners who deceive themselves by assaying the rich streak and assuming that the entire streak will be equally as good. The general principles of sampling the entire body seem to be well understood, although it is not always done as accurately as it should be.

Even when good ore occurs in paying quantities the miner frequently builds a mill that is too large. There is only a little extra expense in increasing the size of the mill after it has been running a while instead of building a large mill all at once; so there is little excuse for assuming the greater risk of a large mill. On the other hand, there is less loss of gold in adjusting a small mill.

One agreeable exception to the practice of building a mill before the mine is sufficiently developed is seen in the work of the Whitney Company, which has carefully tested and explored a number of mines. At the old McMackin Mine at Gold Hill, as explorations proved the value of the mine, the contemplated scale of working was gradually increased. When the small shafts of the upper levels were deepened, the lower parts were made large enough for balanced hoisting and the small part will be enlarged later. In the meantime most careful sampling and assaying was done, and when enough ore had been blocked out, careful mill tests were made, chiefly upon the material obtained from drifts. In this way a total of 4,950 tons of ore were run through the little mill on the ground. Careful records were kept of all mill runs, which showed an average recovery of \$4.52 of gold on the plates and only \$0.34 per ton in the concentrates, making

them worth but \$5.03 per ton, and \$0.83 per ton in the tailings. These tests clearly demonstrate that the most economical method of treating this ore is simple amalgamation, giving a saving of about 80 per cent. of the gold, with no attempt to concentrate and treat the concentrates.

The two main shafts are down 800 feet and another is 400 feet deep, with the levels averaging over 700 feet long. This work shows a vein averaging 14 feet wide and gives a million and a half tons of ore blocked out ready to stope, which will yield \$2.50 per ton by amalgamation. They have accordingly planned a mill large enough to treat 1,000 tons of ore per day, and the estimated total cost of mining, milling and transporting the ore is \$1.48 per ton. They are now waiting for the completion of their water-power plant before building the mill, and, since they have sufficient ore blocked out, the mine has been idle and full of water since the spring of 1905. The intention has been to keep a reserve of 500,000 tons of ore in advance of the stoping. It is hoped that the recent death of Captain E. B. C. Hambley, manager of the company, will not cause the plans to be changed.

The Bonnie Doone, or Old Smart Mine, has also been properly developed by Mr. J. C. Bates, a former owner of the Howie Mine. The old 80 foot shaft has been deepened to 200 feet, with levels 125 feet long at 60 feet, 100 feet at 120 feet, 160 feet at 186 feet. The ore obtained from these workings is now piled in a large dump estimated to contain 3,000 tons. Before the mill was planned, this was carefully sampled by a competent mining engineer, who dug deep trenches across it and found it to average \$15 per ton. Of course a great deal of the same quality of ore has been blocked out in the mine. There are about 500 tons in another dump of material which came from work in the walls and is chiefly slate, but contains a few of the veinlets and masses of milky quartz, and is said to assay about \$1.50 per ton. It has been kept separate from the good ore at only a nominal expense. The mill has not been built on account of the continued sickness of the owner; so there is no machinery at the mine except the large prospecting hoist.

As an example of a mill too large for the development may be mentioned the Reimer Mine, near Salisbury. Here a 20-stamp mill with chlorination failed simply because no ore at all had been blocked out and it could not be mined rapidly enough to keep the mill going. An examination of the mine by the late Mr. Parker,

mining engineer for the Whitney Company, showed a remarkably continuous vein, averaging $3\frac{1}{2}$ feet wide and carrying \$7.50 in gold.

Mr. Parker planned to develop the mine so that it might easily yield 50 tons per day; and so the total cost of mining and treating the ore would be about \$4.50 per ton, which includes depreciation, etc.

The general custom of having no reserves of ore blocked out prevents conservative mining men from investing in them, since there is no way of determining the value of the vein unless it is opened up. It would be much better to spend the cost of a premature mill in developing ore so that there would be no difficulty in securing capital or selling the mine to advantage.

It is also quite customary to extract all of the ore by underhand stoping. This becomes very expensive when the vein is so narrow that some of the wall-rock must be broken to make room, or when the vein contains much barren rock. All of this waste material must then be hoisted to the surface and much of it becomes mixed with the ore in the bins and chutes. If the stopes are mined upward or overhand all the waste can be left in them supported on a single line of stulls over the drifts. This often affords a scaffold for the men and so saves the great expense of putting in many stulls. In addition a large block of filling will serve as a pillar to hold the walls apart so no ore need be left in the mine. One excellent mine superintendent said that the reason for this was the fact that most of the miners are more properly farmers and cannot drill holes upwards. They do not work steadily enough to warrant an attempt to teach them how, even though skilled men prefer to drill "uppers." This objection can be overcome in those mines having air drills for driving levels by installing a few of the block-holing or air-hammer drills which may be held in one hand and, besides being much quicker, can be worked in stopes too narrow for hammering by hand. So far there seems to be none of these machines in North Carolina, although they are becoming standard in the West.

When the mines yield rich ore in narrow streaks, it should be hand-picked before going to the mill. For this purpose the Miami Mining Company has installed at the Phoenix Mine, near Concord, Cabarrus County, a satisfactory ore picker, which is manufactured by the Colorado Iron Works Company, of Denver. The ore is sorted into coarse and medium material by passing through a trom-

mel, where it is also washed by a spray pipe. It then passes over a couple of belts 30 inches wide and 30 feet long. A number of boys sit along these belts and pick out the waste, which is removed by another belt, while the good ore passes direct to a Dodge crusher. The dirt and fine ore removed by the water were raised by a sand pump directly to the battery. These machines would not pay at a small mine, and an arrangement like that installed at the Hercules Mine at Cid, Davidson County, is better. Here the ore is dumped from the skip on to a slightly elevated platform, where it is washed by a stream of water from a hose and the waste thrown into a car standing near, while the good ore is shoveled into a car and taken into the mill.

Since the publication of Bulletins Nos. 3 and 10 of the North Carolina Geological Survey, there has been a number of changes in mining practiced in the State, which given in the order of their probable importance are:

1. The application of machines of the old log-washer type (the Modern Pulverizing and Concentrating Machine) to separate gold from saprolites, as is now being practiced at the Shuford, Empire, Beaver Dam, Troy, Sawyer and other mines.

2. The introduction of square set timbering in the extraction of soft, deep ore bodies, which is now being practiced at the Union Copper Mine, Gold Hill, Rowan County.

3. The introduction of the cyanide process for treating certain sulphuret ores, which has been practiced on the tailings from the Iola, Montgomery and Howie mines.

4. The introduction of self-dumping skips, picking belts, etc.

There have been but very few new localities opened up and developed since the publication of the bulletins mentioned above, so that the present report is something in the nature of a supplement to Bulletin 3, bringing the description of the various properties up to the present time; but giving but little that is new in regard to the geology of the occurrence of the ore. The recent changes in mining practice are described in considerable detail and there is given a short account of all the mines that were operating in 1905 and 1906.

RECENT CHANGES IN GOLD MINING IN NORTH CAROLINA.

BY A. A. STEEL AND JOSEPH HYDE PRATT.

LOG WASHERS.

Perhaps the most important change to be noted in gold mining practice in North Carolina is the introduction of log washers in treating many of the saprolitic ores that are found quite abundantly throughout many portions of the State. The old principle of the log washer (see Plate XX, B) cannot be patented, but the machines that are now being used, known as the Modern Pulverizing and Concentrating Machines, possess many mechanical improvements that adapt them to the work that they are called upon to do.

Each separate unit of these machines consists of two improved log washers running at high enough speed to readily disintegrate the soft material and so mix the clay into a fine pulp with water that the gold can readily settle to the bottom. Each machine is essentially a long trough of boiler-plate containing a revolving cylinder fitted with heavy white iron arms, set spirally, so that the ore, while being hammered fine, is gradually worked to the discharge end. At the end of the first washer the larger, hard and nearly barren quartz stones are removed by a revolving screen and belt conveyor, this being done to save wear and power in the second washer, where the gravel is still further reduced in size and more gold settles out. The gravel that remains after passing the second washer is removed by a finer screen, and the thin pulp, free from stones, passes into the riffled sluices, about 3 feet wide and of varying lengths, which contain mercury to amalgamate and save any free gold that does not settle in the machine.

The steel troughs are about 2 feet wide by $2\frac{1}{2}$ feet deep, the first being 18 feet long and the second 12 feet, with a semi-circular bottom and a flat wood top. The revolving cylinder is made of an 8-inch steam-pipe, carried upon a heavy steel shaft, passing through stuffing-boxes at the ends of the trough. Wrought-iron bars reach through this pipe crosswise and project about 3 inches on each side to form legs, to which $8\frac{1}{2}$ -inch cast-iron arms are bolted to take all the wear. There is about 4 inches clearance between these arms and the bottom of the troughs, which allows the formation of a bed of stones, which

reduces the wear on the bottom and helps save the gold. This bed of stones is, of course, more or less shaken up by blows from the large fragments of quartz and by the revolving arms, thus permitting the gold to settle through, as in panning. The constant striking of the paddles against the surface of the water will also weight and sink some of the float gold. The discharge end of the machine is set 6 inches higher than the feed end, so that the gold, once down amongst the pebbles of the bed, is not apt to be pushed out.

Riffles of the sluices are made by boring inclined auger holes in the planks laid lengthwise in the cement-lined sluice-boxes. Since all the coarse gravel has been screened out, there is little wear upon the riffles, and the fall and quantity of water are less than in the regular sluice for hydraulic mining. In cleaning up, the planks are lifted up and turned over and the gravel and mercury washed to the end of the sluice, where quicksilver and amalgam are washed out in hand-pans. When through cleaning up, the planks are simply replaced and the riffles filled with mercury and the machine started again.

In cleaning the washers, which is usually done twice a week, the machines are stopped and all the gravel within washed out with a hose through an opening in the bottom. This gravel is then panned by hand and the gold amalgamated. Any nuggets that occur in the rock are pounded free from quartz and are then also amalgamated.

The amalgam from all sources is strained out of the quicksilver and then retorted and the bullion sold.

The chief wear on the machine is on the arms, which, under certain conditions, as on the sharp ore at the Shuford Mine, only last six weeks. They can, however, be readily made at any foundry.

It is recommended by the makers that the first washer be driven at 150 to 250 revolutions per minute, and the second one at 250 to 350 revolutions per minute, and that for a capacity of 10 tons per hour each machine be given 75 gallons of water per minute. This will then at times require 25 horse-power for a complete unit of two washers and trommels. These factors will vary greatly with the character of the ore. Since the power, and therefore the wear, will increase even more rapidly than the square of the speed, this should be kept low. In the absence of any coarse stones, there is also danger that the pulp may be too greatly agitated to allow the settling of the gold. On the other hand, the speed and work must

be sufficient to grind up the ore. If there is too little water, the clay paste may not allow the gold to settle. If there is too much, there is danger of the gold being washed out. While a large capacity is of advantage and desirable, still it will mean danger of insufficient grinding, too thick pulping or too strong a flow of water. A great deal of skill and patience is therefore required in adjusting these fixtures, but when once adjusted, they will work satisfactorily. It is to be recommended that a first unit be installed and run for several months at various speeds, capacities and amounts of water, and the machine should be given plenty of time after each change of condition to adjust itself. Also, careful tests of the ore and tailings should be made between times. The capacity and speed should first be adjusted until the best result is given in reducing the amount of gold left in the tailings, so combined that it will not pan. The pulp should, of course, be kept at a reasonable consistency throughout the changes, and the amount of water finally adjusted so that the tailings will show a minimum of free gold in the pan.

These machines are made in Knoxville, Tenn., and are handled by George L. Erdman, of Asheville, N. C. One of the first of these machines was installed at the Shuford Mine, owned by the Catawba Gold Mining Company and situated about three-quarters of a mile north of the post-office of Edith, about 5 miles southeast of Catawba Station, on the Southern Railway. They have a plant of four double units. The company is operating on a tract of land containing a gold-bearing zone, said to be 2 miles long and 600 feet wide. This will all pan gold at the surface, and has been tested by bored holes 30 to 50 feet deep to water-level, and by one old shaft 115 feet deep.

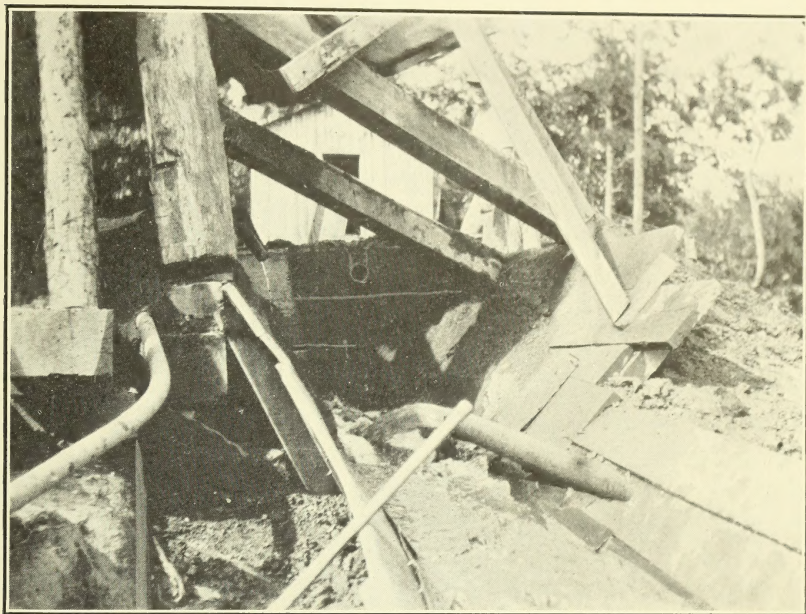
The schists strike nearly east and dip some 80° to the south, but are much crumbled and variable. The gold-bearing zone strikes about N. 40° E. The zone is intersected in all directions by quartz veinlets up to 6 inches thick, but there is no relation between them in dip, strike or spacing.

This zone is filled with small quartz seams from a line to occasionally several inches thick, and having all possible strikes and dips, and seldom more than 2 feet apart in every direction. The country rock varies from schist to gneiss, and is generally heavily stained by iron oxide and thoroughly decomposed, except for a few bold outcropping hard masses. The quartz is usually thoroughly honeycombed and broken into soft, angular fragments. Except at the sur-

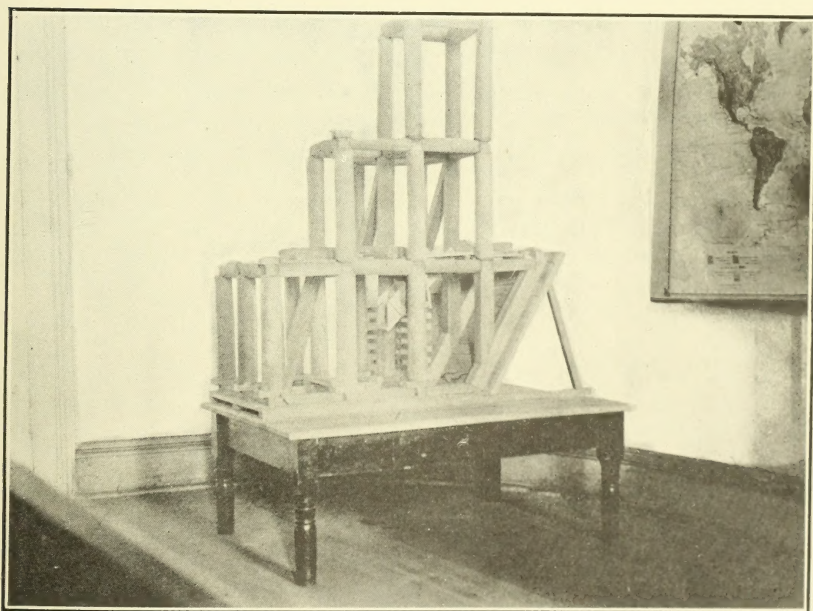
face, most of the gold is in these quartz streaks, but the hard and solid portions of them seldom have much value. At the present time the entire mass is being mined by means of an irregular pit, which was, in the summer of 1906, 90 feet deep and 250 to 300 feet across at the top. The material at the bottom is just as soft and decomposed as at the top, and the ore is loosed by black powder and shoveled by hand into cars containing a cubic yard. (See Pl. I, B.) The cars are hoisted up a steep incline and automatically dumped over a grizzly of light steel rails. The fines are washed through the grizzly by jets of water, the soft, large lumps being crushed and knocked through by means of a pick. (See Pl. II, A.) In 18 months' operation only a few tons of large, hard lumps have thus far been thrown out. The material is then washed down a trough about 50 feet long, thus becoming pretty uniformly mixed before being divided among the washers. At this mine the machines are run at only 150 revolutions per minute. They were tried at a lower speed, but there was trouble with the gold sticking to clay balls. The machine used about 150 gallons of water to the minute, and the whole plant is run by a 35 horse-power engine, which, when the three units are running, is probably overloaded. The tailings, when tested, usually pan nothing at all, but assay a few cents, due to gold included in the sand. While this loss could be reduced by speeding up the second washer to grind the sand finer, and trusting to the riffles to save what little additional free gold would not then settle in the machine, it is doubtful whether with the present small plant and such a vast quantity of ore as is controlled by the company, if such refinements are advisable, since they would probably reduce the capacity of the plant. It is estimated that the present cost of treatment is 22 cents per cubic yard, loose measure, with a recovery of between 50 cents and a dollar per cubic yard.

A great deal of the success of the Catawba Gold Mining Company is due to its conservative policy and the skill with which the whole mining and milling operation has been conducted.

The next machine to be placed in successful operation was at the old Laffin Mine, near Cox, Randolph County, about 4 miles east of Cid Station, on the Thomasville and Glenanna Railway. The Empire Mining Company owns a tract of land which contains argillaceous slates containing two gold-bearing zones 200 feet wide by half a mile long, the northwest zone being along the south side of a



A. HEAD OF STEEP INCLINE, WHERE ORE IS DUMPED ON GRIZZLY, SHUFORD MINE, CATAWBA COUNTY, N. C.



B. MODEL OF SQUARE SET TIMBERING, SHOWING LOCATION OF AN ORE CHUTE.



hard quartz and siliceous slate vein. The early work on this property was done at the northeast end of the northwest zone, where there are several large pits, some 50 feet deep. The entire surface was tested by pan assays (weighing the amount of gold from known weighed amounts of ore), and a number of trenches were dug across the better portions of the zone. The results of this test led the company to install its experimental plant on the gentle slope of another stream near the southwest end of the northwest zone. At the other end the slates are still soft at a depth of 50 feet, but here they were found to be quite solid and tough within 6 or 7 feet of the surface, though drill-holes are said to have proved that the rock is again soft below a 5 or 6 foot shell of hard material. The dip at this end is only 15 or 20 degrees, instead of being nearly vertical, as at the other. This tough slate is thoroughly oxidized and shows a very uniform distribution of wheat-like grains of limonite, formed from pyrite, which lie along the cleavage planes of the slate, and all the gold occurs in them.

The small branch has a steep fall for 2 miles to the Yadkin River, and for the experimental plant water is returned from a small settling pond near by. In order to get sufficient fall for the head and tail sluices, the machines are put pretty high up on the hill, so that a flat incline has been put in, with dumping arrangements, etc., similarly as at the Shuford Mine. The ore is broken up by hand into about 3-inch cubes, and, when not hard, there is some tendency for it to stick in the grizzly crusher, owing to the large percentage of clay, which is often moist. The first machine is run as high as 250 revolutions per minute on hard rock, but was found to give best results on average partly decomposed slates at 175 revolutions per minute. As there is no hard quartz in this ore, there is no need of an intermediate trommel. The second machine is operated at only 90 revolutions per minute, and saves most of the gold, which is very fine. The trommel, which follows this washer, removes practically nothing but fragments of tree roots, which shows that everything is ground below 4-mesh. The riffles are 64 feet long, but very little gold is found below the first 20 feet. With this soft, clayey ore the capacity is about 8 tons per hour, and 110 gallons of water per minute are required. In the summer of 1906 the machine had hardly passed the experimental stage, but the tailings almost never showed any free gold, and assays of carefully taken samples showed a re-

covery of 90 per cent. on the soft material and 80 per cent. on the hard.

A few modifications of the machine have been made by Mr. O. K. McCutcheon, superintendent of the Empire Company, by introducing an improved stuffing box and valve for the clean-up openings, and in the second washer installing a plate 9 inches wide and 1 inch above the center of the bottom, with cross-lots $\frac{1}{2}$ inch by 5 inches. This false bottom is curled up at the discharge end and serves as a riffle-plate, thus considerably increasing the recovery of very fine gold.

One double unit of these machines was being worked on the property of the Troy Mining Company, 7 miles north of Troy, Montgomery County. There are some old shafts, but the two main workings are based upon recent discoveries. By test-pits and panning, it seems there are two parallel zones of slate bearing gold. Open cut No. 1 shows white and pink clay-like slates with iron stains and abundant limonite cubes and seams. The direction of the slates is N. 45° E., and part of the material seems to represent thoroughly decomposed, sheeted, coarse-grained porphyry, so that the deposit is probably on a contact. The values are not uniform, and at a depth of about 12 feet the deposit seems to be about 20 feet wide, 50 feet long, and the upper part of a rounded lens, richest in the center, where a 25-foot shaft is said to have produced \$30 ore. To develop deeper a shaft was sunk in the hanging wall. At a depth of 70 feet it was stopped, just as it began to cut light-colored, sericitic schists, carrying pyrite.

The material from open cut No. 1 was all conveyed by a sluice to the mill, a short distance away. Although a good deal of gold was saved, the tailings ran \$3 a ton, and tests were stopped.

Open cut No. 2 was made by recent unsuccessful hydraulic mining. It was, at the time of the visit, 200 feet long, 20 to 24 feet wide and 2 to 10 feet deep. This zone pans quite uniformly 18 to 20 feet wide in the cut and in cross-trenches beyond the end of it. No assays of average samples have been made. There is a barren white quartz vein, with some large quartz crystals, along part of one side of the zone, and most of the material seems to have been more or less siliceous sericite schist, now thoroughly decomposed to purple clay or fine sand. At the time of the visit, 100 tons were being hauled over muddy roads to the mill, about a quarter of a mile away, for a test run.

The machines were found to give a little less free gold in the tailings as the speed was reduced, until, at the time of the visit, both sections were being run at only 60 R. P. M. The rate of feeding is very low, apparently only 2 tons per hour, and the amount of water is very large, apparently about 150 gallons per minute. There were no hard pebbles or other material in the ore to form a bed in the machine, and it is probable that most of the gold was washed out. Even at this low rate of speed the coarsest tailings were very fine particles of sand. Samples of the tailings included only the coarser, rapidly settling parts, so that the assays made were probably too high. It may be that the slower speed simply decreases the pan assay of the tailings by not freeing such a large percentage of gold which remains included in the larger grains.

The most apparent recommendation would be to put McCutcheon riffles in the bottom of the machine, run the first machine faster than the second, and greatly increase the percentage of ore, compared with water. No samples of the ore had been taken, so the tests are not conclusive.

The latest reports are that the tailings from open cut No. 2 also assayed \$3 to \$4 per ton; so the washers are abandoned and a 50-ton cyanide mill will be erected. It is also said that some good ore was struck below a quartz vein in a 17-foot shaft sunk in open cut No. 2. It is probably well to abandon the washers here, because the thoroughly decomposed soil gets very hard not far from the surface, and the water-level will be less than 30 feet below the highest part of the ore zone now exposed. Therefore, the available tonnage of decomposed material is rather small. A shaft on a third vein, just below the creek bed, shows hard silicified sericite slates, with much pyrite, but no visible copper minerals or other things to interfere with the cyanide plant adapted for handling slimes.

Machines have also been installed at the old Sawyer Mine, in Randolph County, 5 miles west of Sophia and about 14 miles from High Point. This property has been worked, off and on, for many years, but has failed because the gold could not be saved by a stamp-mill and plates. The machine will first treat the soil and very soft outcrops, and then the hard rock, which does not slack by itself, but will be crushed fine by rolls of the machine used simply as a panning device. This will be a new and novel use for this machine, and the results will be watched with interest.

The McCutcheon modification of the Modern Pulverizing and Concentrating Machine is being installed at the old Merrill Mine, on Carraway Creek, 3 miles west of Sophia. The old workings are said to show a zone $\frac{1}{2}$ mile long, which is composed principally of clay to a depth of 50 or 60 feet. There are eight long cross-cut trenches and many test pits have been made which are said to have given ore running from \$1.50 to \$1.90 per ton.

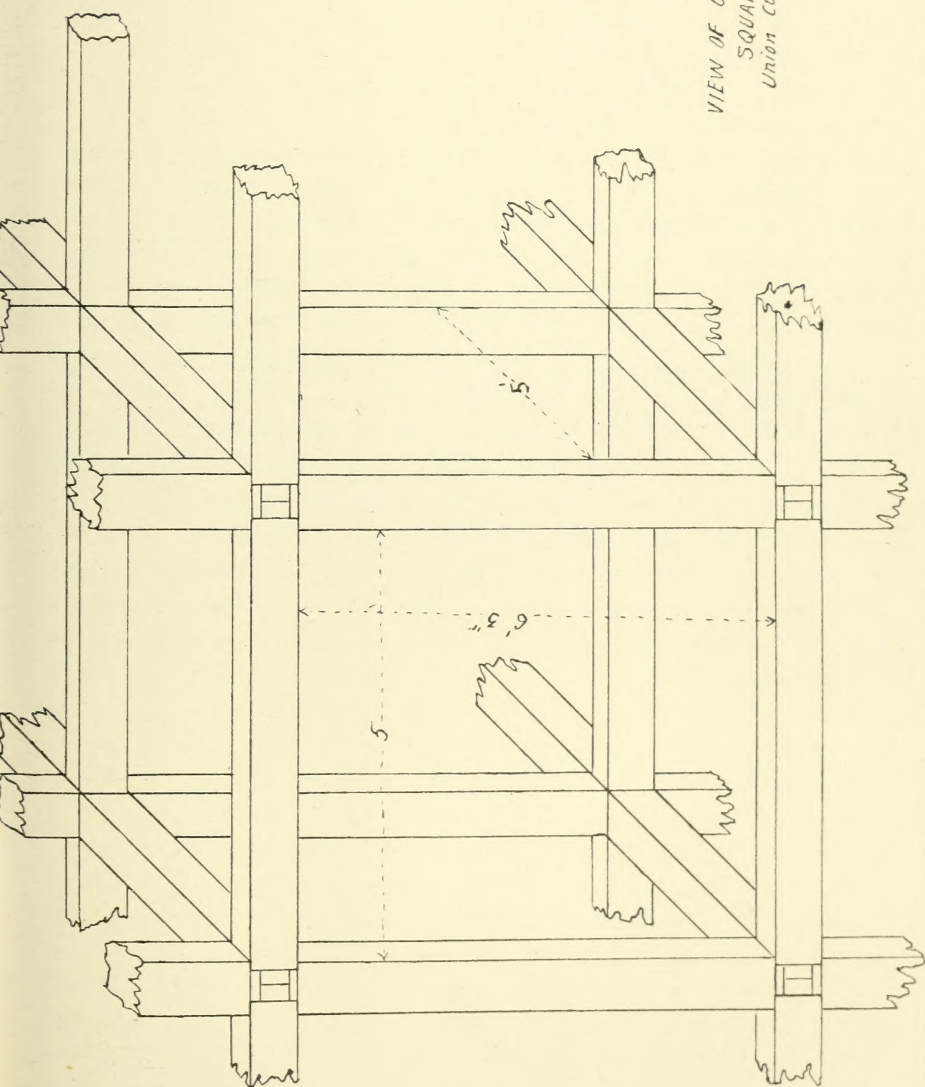
Near Newton, Catawba County, one of the machines is being installed to work a property said to be similar to the Shuford Mine in the same county.

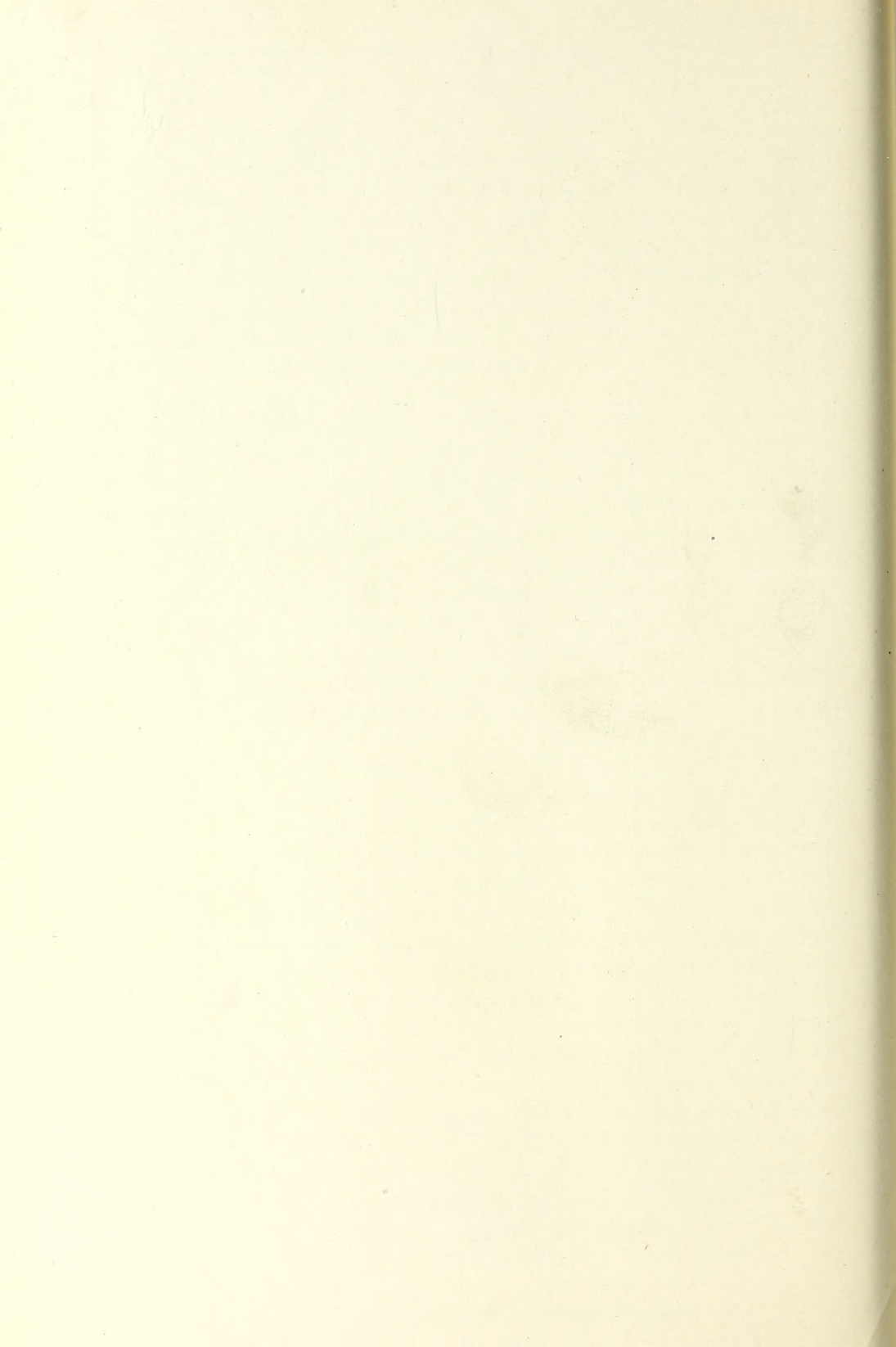
From information obtained by observation in the field and tests in the laboratory, it would seem that this Modern Pulverizing and Concentrating Machine is adapted for certain ores, such as those of the Shuford Mine, and that with certain modifications such as have been worked out by Mr. McCutcheon, the machine can be adapted to still other ores. It is necessary, however, to make a careful study of the ore and to adjust the machine to the particular ore before it can be determined whether or not the machine will save the gold, and a machine should not be accepted or discarded until the ore has been thoroughly tested to ascertain whether or not the machine can be adapted to that particular ore.

SQUARE SETS.

The second change in mining practice of great importance to the gold mining industry in North Carolina is the introduction of square set timbering in the extraction of soft, deep ore bodies. This method was introduced by Mr. H. L. Griswold, superintendent of the Union Copper Company's mine at Gold Hill, N. C. In former mining the old stopes were held open by miscellaneous timbering such as stulls, lock sets and truss sets. Such methods were not satisfactory and prevented the stoping of the ore in the most economical manner. By the introduction of the Western square set method of timbering, the stoping of the ore is being done safely, completely and economically. The perspective cross-section, Plate V, illustrates the use of the square set. The sets are made of 8 x 8 inch sawed oak, and the mine carpenter can usually easily frame enough timber for this work in about one-eighth of his time. The framing is shown in the accompanying isometric sketches, Pls. II, B; III and IV. The sets are 6 feet 3 inches high and 5 feet across in the clear. The posts

*VIEW OF ONE COMPLETE
SQUARE SET.
Union Copper Mine.*





are, therefore, 6 feet 3 inches long between the shoulders and have a 5 x 5 inch tenon $1\frac{1}{2}$ inches long at each end; the caps are 5 feet 3 inches between shoulders and have a 5 x 5 inch tenon $2\frac{1}{2}$ inches long at each end; the tiers are 5 feet between shoulders and have a 5 x 8 inch tenon $1\frac{1}{2}$ inches long at each end.

The size of the timbers will, of course, vary with the weight to be sustained. The style and proportions of framing are very good for oak timbers; but for pine, which crushes so easily across the grain, it is better to have the ends of the post tenons to touch each other. The light timbers are, of course, cheaper and much more easily handled. As the stopes get large, they are more or less completely filled with waste rock which is usually obtained in mining and would otherwise have to be hoisted out in working underhand stopes. This filling also holds the posts in position and helps to prevent them from buckling or "jack-knifing," if any one timber yields, which might otherwise endanger the whole system. Since most of the pressure is downward, as soon as the ore is blasted away to make room for a new set, all the sets below are relieved and tend to come back to their original position. Thus, even light timbers will hold very well if the stope is worked rapidly enough.

In the Union Copper Mine the square sets were founded upon a platform built upon the old, solid-looking truss sets. As soon as a heavy load came upon them the trusses buckled sidewise and everything caved in. A new foundation was then made upon reinforced stulls and there has been no trouble since. Mr. Griswold is starting a new lot of square sets in a large, open chamber just above the fourth level, and he will thus be able to work out easily all the ore left above, especially a big pillar that remains between the first and second levels.

A new set can be added in any position, at any time, without disturbing the adjoining timbers and the old timbers can easily be supported by temporary props while making room for an additional set. When the old timbers have been replaced, the entire flooring of sets is easily put in as the ore is removed, a temporary plank covering being placed across the old timbers to protect the men from falling rocks. Temporary plank floors are placed upon the sets for the men to stand upon, and, as the system becomes higher, chutes and mill holes are put in to conduct the ore to the car or the track below. Any waste rock mined is merely dumped in and around the lower

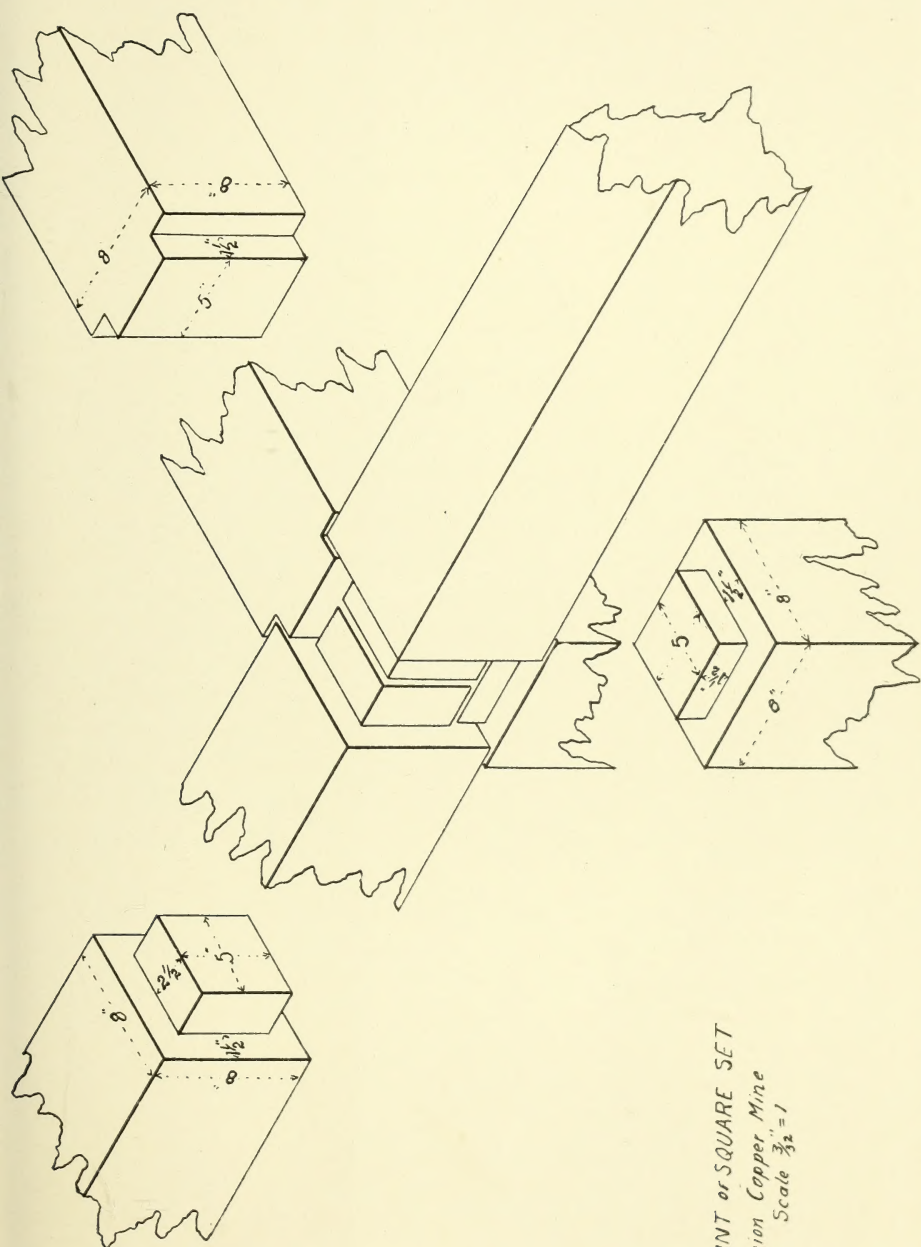
sets. In the diagram, Pl. V, these lower floors are omitted for the sake of clearness.

There has been little or no trouble in introducing the square set method of timbering, and at the Union Copper Mine the work is done under the immediate supervision of Mr. Hedrick, a skillful North Carolina shift boss, who has had no previous experience with square sets. Some of the miners, especially negroes, when first stoping by means of square set timbering, are a little nervous because they are so close to the roof that they can see how loose the rocks are; but this passes away as soon as they realize that they can pick down the loose rock or prop it up and, therefore, are safer than when they are so far away that they cannot tell at what moment the rock may fall upon them. Also, when working at the bottom of a high, underhand stope, a blow from even a small rock would be dangerous.

CYANIDE PLANTS.

The introduction of the cyanide process for treating certain sulphuret ores is a third change in mining practice in the State that has added considerable to the production of gold. One of the most successful cyanide plants was the one erected to work the tailings of the Howie Mine, near Waxhaw, Union County. This mine is a zone of hard, siliceous slates, carrying chimney-like bodies of rather high-grade ore. The gold is all free, but so finely disseminated that the high-grade ore, which is a laminated or schistose quartz, has merely a golden sheen. A great deal of this escaped amalgamation, although enough was saved to pay well. These old tailings, which are rumored to have been worth five or six dollars a ton, soften somewhat upon exposure to the weather so that the recovery by cyanide was very good.

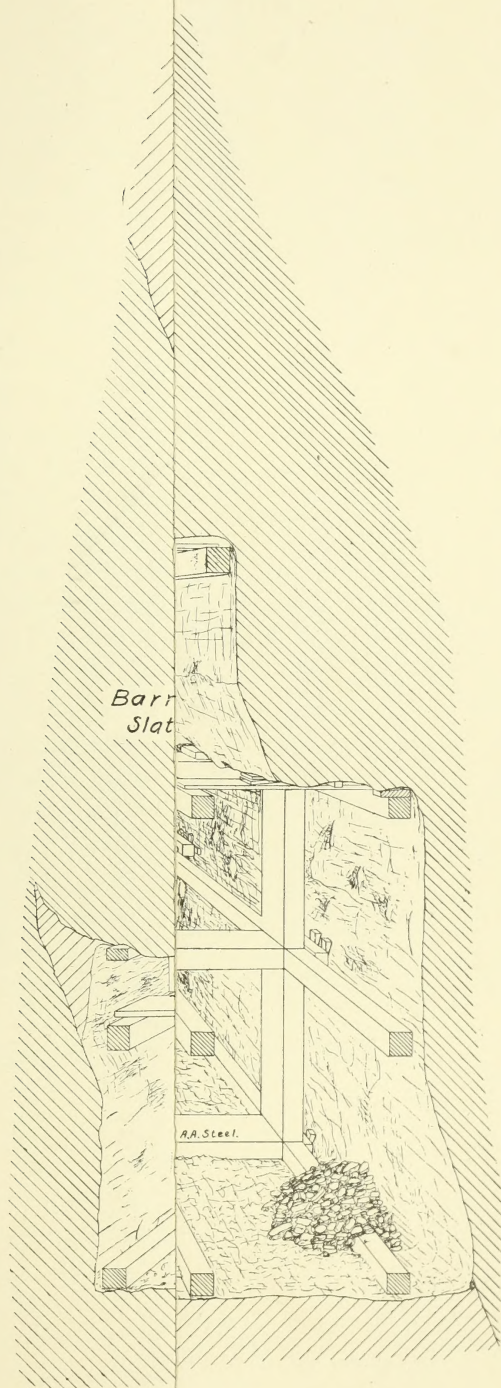
The old cyanide plant had four iron tanks $5\frac{1}{2}$ feet deep and 30 feet in diameter and supposedly the necessary other tanks and apparatus. When the tailings were exhausted the mine was sold to the Colossus Mining Company, a London corporation, which proposed to put in an immense plant to treat the entire zone. This zone had previously been cross-cut by two trenches somewhat over 20 feet deep, but it was never properly sampled, for, although there are many fairly rich streaks, the general average value is only 40 to 50 cents a ton. The tanks of the old mill were made a part of the new big mill, so the original arrangement of this successful plant could not be learned,

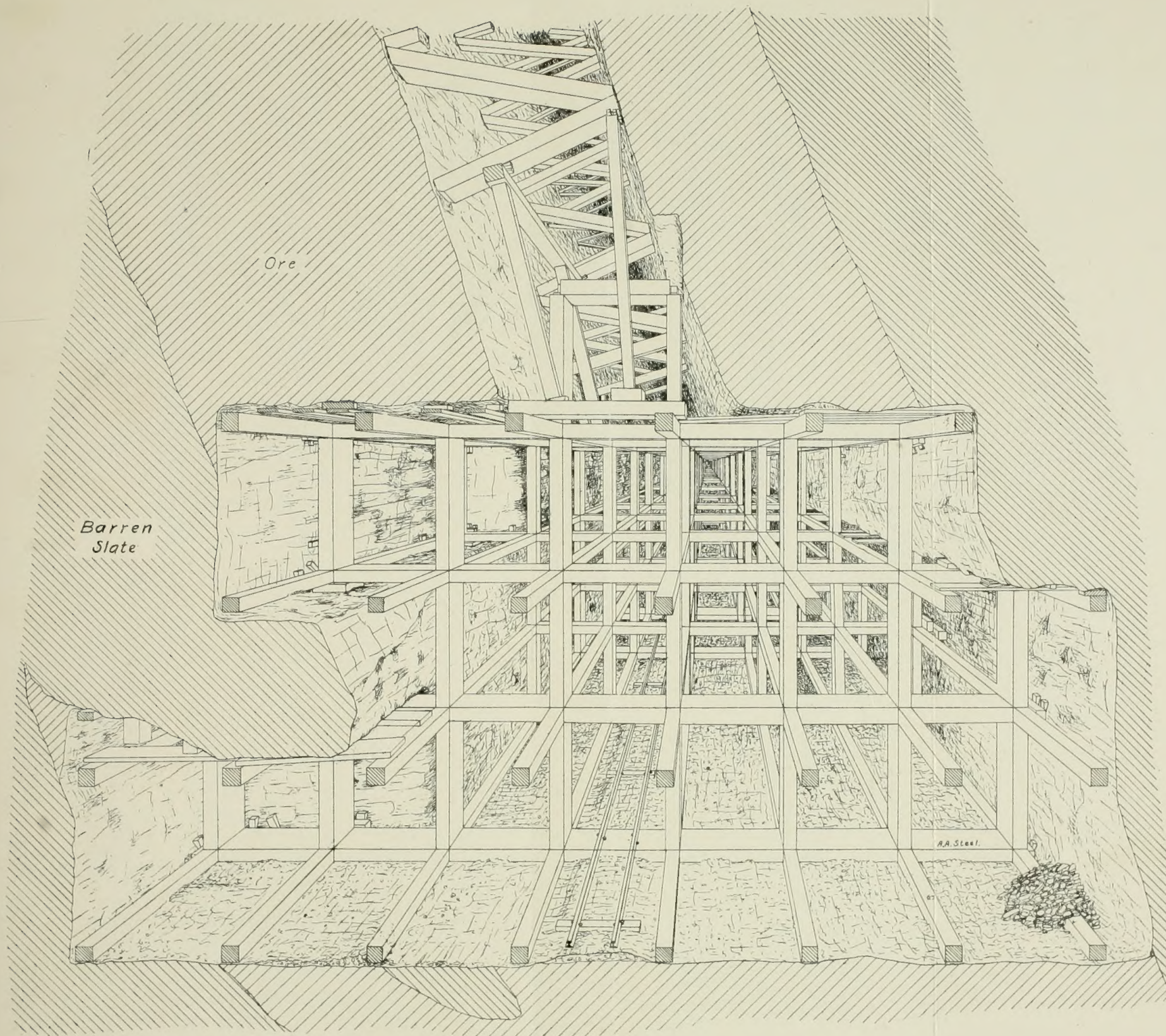


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Union Copper Mine
Perspective Section.
Old Stope with Lock Sets, Enlarged by Square Sets

and also no one could be found to give information about the successful treatment. There is now a Ledgerwood cableway for the economical handling of excavated rock. This dumps the skips of rock upon the feeding platform of a very large gyratory crusher discharging into a trommel. The coarse rock from the trommel goes through a smaller gyratory crusher into the bin containing the finer rock. From this bin it is hoisted to a long, rotating cylinder dryer discharging to the first of a pair of Allis rolls working in series with necessary screens and elevators. The fine material from these rolls is divided among three ball mills of peculiar design. They have a vertical axis bearing arms which push a number of six-inch iron balls around a horizontal runway.

There are at present no screens on these, and the product contains a good deal of troublesome dust or slimes, and some sand too coarse for successful cyaniding. From the ball mills a fine set of conveyors carries the dry material to any one of the leaching tanks. There are six tanks $5\frac{1}{2}$ feet deep and 40 feet in diameter, and four tanks $5\frac{1}{2}$ feet deep by 30 feet in diameter, all in the open air; and the necessary solution, gold and slump tanks. The design of the mill could be improved, since the rolls have scarcely capacity for 75 tons per day, and the ball mills were so overworked that much coarse sand passed through them. On the other hand, the crushers, elevators, etc., have a capacity fully four times as great. The mill has been used by the present management in making cyanide tests upon the rich ore remaining in the chimneys. Even when crushed very fine this fresh unaltered ore can be leached for a week without giving up more than half its gold, and so this cyanide plant is not the method to use for this ore.

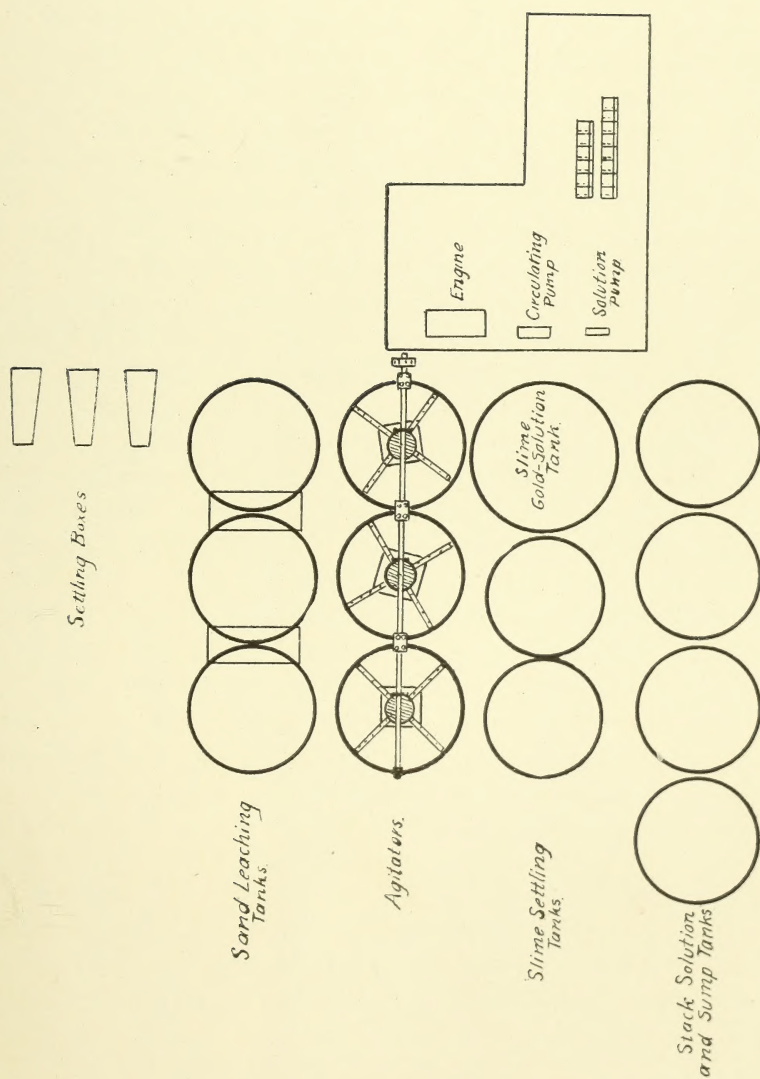
At present the most productive cyanide plant in this State is the one at the Iola Mine, near Candor, Montgomery County. The general plan is shown on the accompanying sketch, Pl. VI. The ore, coming from a pretty sharply defined vein, is either a hard, glassy, white quartz, with traces of unreplaced slate and carrying coarse gold in octahedral crystals, or soft, sugary, white quartz, generally richer, but not showing visible gold. This "sugar quartz" has lately been running from \$14 to \$20 per ton. It is crushed in a 20-stamp mill where the coarse gold and much of the fine gold is amalgamated as usual. The tailings are elevated and run to the various settling boxes or "sand-boats"; three of these are 3 feet wide at one end,

5 feet at the other, 12 feet long and $3\frac{1}{2}$ feet deep; at the small end is a wooden lattice, on the inner side of which a canvas curtain may be rolled up from the bottom. When the thin tailings run into this the sand settles out and the fine part or slimes flow into the slime tanks. As the sand accumulates the curtain is unrolled so that the overflow is just above the level of the top of the sand. The other two sand-boats, just above the tanks, are plain boxes 6 feet by $3\frac{1}{2}$ by 15 feet. One end is bored full of holes to let out the slimes. These are plugged as the level of the sand reaches them.

The wet sand from these boats is shoveled or wheeled into whichever of the sand tanks may be empty. This shoveling thoroughly breaks up any water-tight layers of slime which may have formed when the mill was shut down for a short time, and the thin pulp remaining below the overflow has a chance to settle in a layer on top of the sand. It also supplies the needed oxygen to aid the cyanide in dissolving the gold. The sand tanks were made locally of yellow pine and are 4 feet deep and 20 feet in diameter and there is the usual cocoa matting filter in the bottom. When filled to convenient height, they hold 40 tons of sand. A solution containing 1.4 pounds of potassium cyanide per ton of water is pumped upon this and drained off through the filter; this solution is kept circulating as rapidly as possible, keeping the sand always covered for three or four days until the sand must be removed to make room for another batch. Then the solution is allowed to drain off, after which a little water is added to displace what solution remains in the damp sand. The sand is then washed out by a stream of water from a hose through an opening in the bottom of the tank into a trough or launder, to a settling pond where the sand settles out and the water collects to be pumped back again.

The slimes flow from the sand-boats to one of the three agitation tanks 10 feet deep and 20 feet in diameter. Near the bottom of each of these slowly revolves a paddle consisting of four well-braced oak arms carrying pins. Some of the surplus water is drained off and a solution carrying one pound of potassium cyanide per ton of water (0.05 per cent.) is added. The agitation continues while the solution and slimes are drawn off at the bottom to a 4-inch centrifugal pump, thus thoroughly aerating and mixing it. This process continues until the tank is needed for more slimes. The solution is then pumped into one of the settling tanks 14 x 18 feet at a little lower

SKETCH PLAN
CYANIDE PLANT
IOLA MINE



level. Here the solid matter slowly settles out and the clear solution is drawn off. Sometimes the slimes are returned for a treatment with a second solution until they are finally sluiced out as waste. The solution from the sand tank, which now contains the gold, is passed directly to the zinc boxes; these have six compartments, 2 x 2 x 2 feet, with a side trough and a diaphragm for circulating the solution, as shown in the diagram. This arrangement allows any one box to be emptied and cleaned while the solution circulates through the others. See Plate VII.

From the zinc boxes the solution flows to the sump tank, 10 x 20 feet. Here more potassium cyanide is added to replace what has been consumed until the solution reaches the right strength. This sump tank thus serves for a stock solution tank, from which the solution is raised by a small centrifugal pump to the sand leaching tanks. Most other mills have a small extra tank at the highest level in which the solution is made up and from which it flows by gravity to the sand tanks.

The clear solution from the slime settling tank is stored in the tank 24 x 8 feet. From this it flows through an eight compartment zinc box like the other one and to the sump and weak solution tank.

In the zinc boxes, zinc from a mass of fine zinc shavings enters the solution in place of the gold, which is precipitated as a black coating upon the zinc. Each month the zinc in the boxes is sifted and the fine stuff saved, and the coarse stuff returned to the box. The deficiency of coarse zinc in the first box is made up by taking some of it from the second, which is in turn filled from the third, and so on. All the fresh zinc required is added to the last compartment, and, since much of the gold sticks to the zinc until it is all dissolved, most of the gold slimes are recovered from the first compartment, where precipitation is also most active, as the solution passing through it contains the largest percentage of gold.

The gold slimes, or finely divided gold, containing small scraps of zinc, is melted in a graphite crucible, to which a little nitre is added to oxidize the zinc and cause it to unite with the borax used as a flux. The melted gold is cast into bricks and sent to the mint.

All the tanks are in the open air. The pipes are wrapped to prevent freezing, and there is no trouble except that heavy rains increase the amount of solution which must be wasted and so cause a greater loss of potassium cyanide. The pumps and the engine for

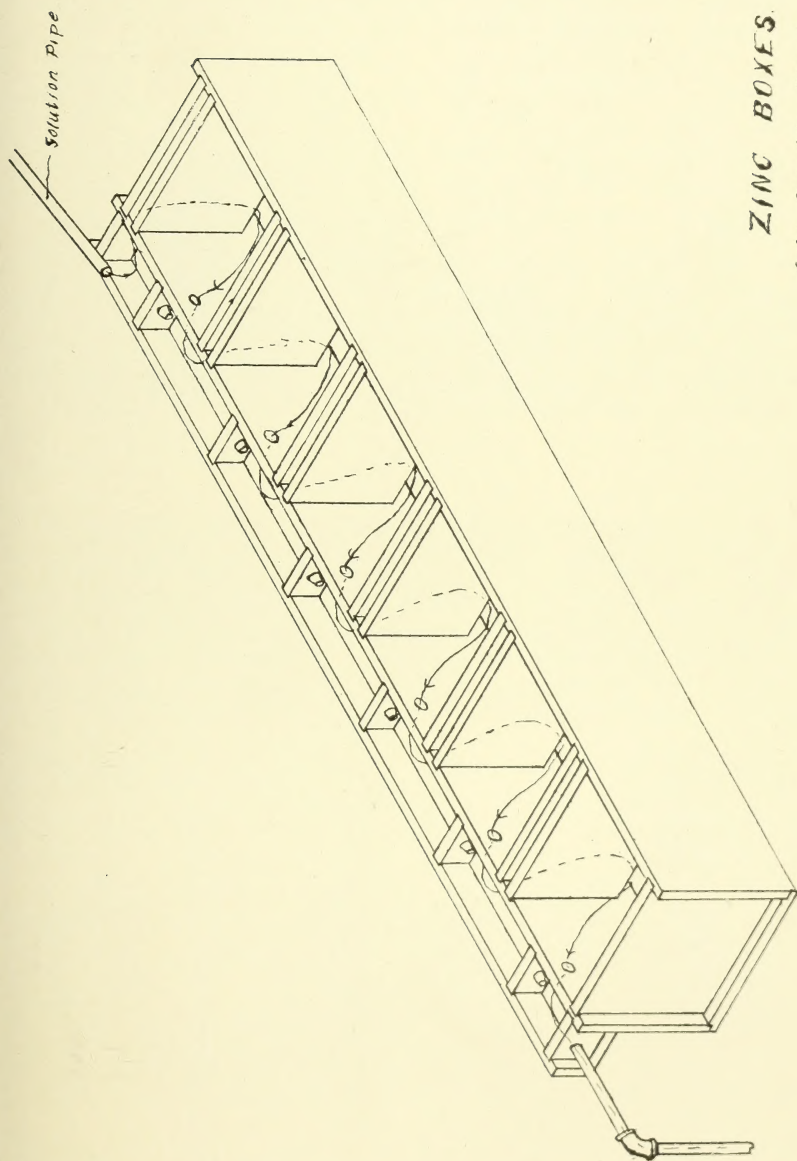
driving them and the agitators are housed in. In the same building is the room containing the zinc boxes and furnace for melting the bullion. About four-tenths of a pound of potassium cyanide is consumed per ton of ore. In the ore are no copper minerals or similar substances to consume cyanide.

Eight pounds of lime are added to each ton of tailings on its way to the cyanide plant. This is to cause the slimes to settle more readily and neutralize any acid which may be formed from the pyrites in the ore, and which would otherwise consume cyanide. The chief loss of cyanide is, therefore, in the solution that is wasted with the wet slimes.

There is required one solution man at \$1.50 a day and two negroes at \$1.00 a day for each shift. If one-half of the steam used at the mill is charged to the cyanide plant, the total cost exclusive of interest and depreciation is \$0.90 per ton. The tailings from the cyanide plant contain about \$1.00 per ton of gold. Since the sands from the mill had been carrying \$4.86 per ton, there is a handsome profit in the cyanide plant—about \$2.90 per ton treated. The cost of the plant was from \$10,000 to \$12,000. The loss in the tailings could be reduced by a longer treatment of the sands, and the intention is to add two more sand leaching tanks for this purpose.

The data as to the cyanide treatment were mostly obtained from Mr. W. T. Sawyer, former superintendent, and checked as far as possible by Mr. Jones, the present superintendent.

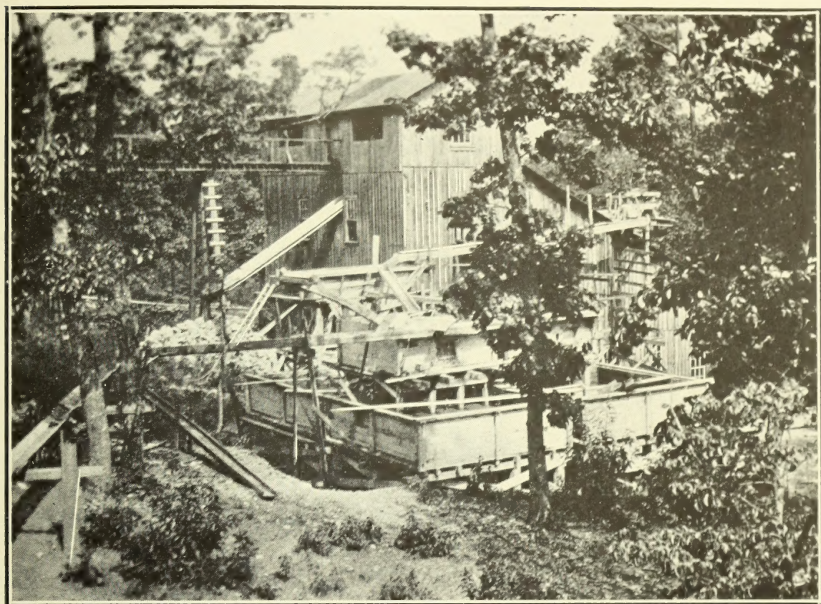
At the Montgomery Mine, which adjoins the Iola, there is another cyanide plant for treating tailings from a 10-stamp mill. This is shown in Plate VIII, A and B. All of the tanks are square. The stream of tailings is first separated into slimes and sands in a pointed box. Near the bottom of this box is a pipe out of which the coarse sand, which settles most rapidly, flows to the settling tanks, over the sand tank, while the slimes overflow at the top opposite the inlet. The slimes are not treated and the sand treatment does not differ essentially from that at the Iola. The mine was shut down at the time of the visit, so no data as to the cyanide treatment could be obtained. From the relatively greater tank capacity, the sand probably receives a longer treatment. The solution tanks and zinc boxes are inside the mill.



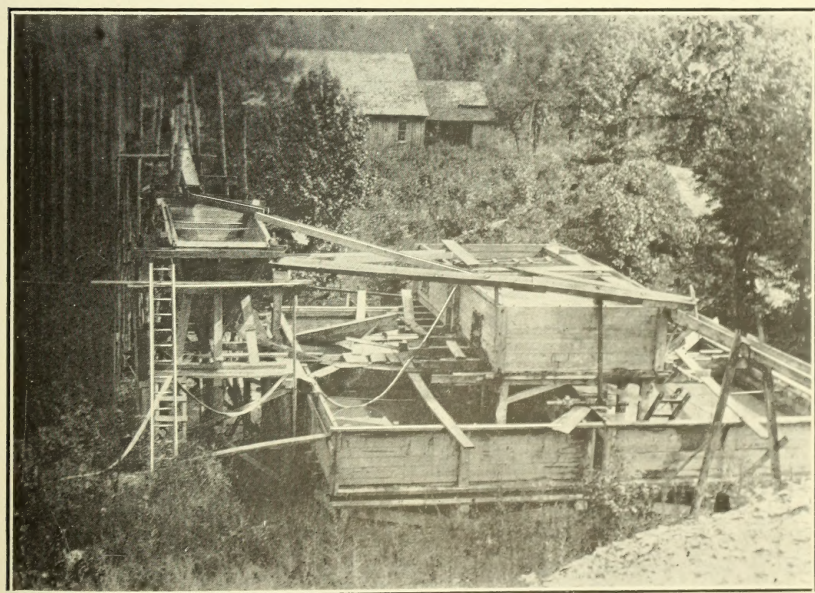
ZINC BOXES.

Sola Cyanide Plant.

Scale $\frac{3}{8}" = 1'$



A. CYANIDE PLANT, MONTGOMERY MINE, MONTGOMERY COUNTY, N. C.



B. SAND AND SETTLING TANKS OF CYANIDE PLANT, MONTGOMERY MINE,
MONTGOMERY COUNTY, N. C.

There is a new cyanide mill at the Southern Homestead Mine, 13 miles south of Thomasville, near Cox, Randolph County, built at a cost of about \$24,000.

The ore passes over a grizzly, the oversize from which goes through a Blake crusher, and, with the fines from the grizzly, are elevated to a trommel screen above a small storage bin. The oversize from this trommel passes through a pair of corrugated rolls, then back to the same trommel, and so on, until it is all reduced to sand. The corrugated rolls chattered badly on account of the coarse feed and soft clayey ore sticking to them, so it will probably be better to use instead a number of smooth rolls in series.

The fine, dry ore is taken by a belt conveyor to one of the three sheet-iron leaching tanks, 6 feet deep and 30 feet in diameter. It was assumed that the solution would percolate through the $5\frac{1}{2}$ feet of dry, crushed ore, even though the slimes were not removed; but in the actual tests the tanks were filled only half full. Below the level of these leaching tanks are zinc boxes and sump tanks; the three solution tanks are on a trestle outside the main building, covering the leaching tanks.

Work was abandoned after treating 150 tons of ore, which averaged only \$2 a ton. No data as to time of treatment, strength of solution, etc., were obtained. The recovery on the three tanks tried was 70, 80 and 83 per cent., respectively. The ore is decomposed rock, occurring in wide zones and carrying a great deal of clay. No data was obtained as to the capacity of the mill.

SELF-DUMPING SKIPS, PICKING BELTS, ETC.

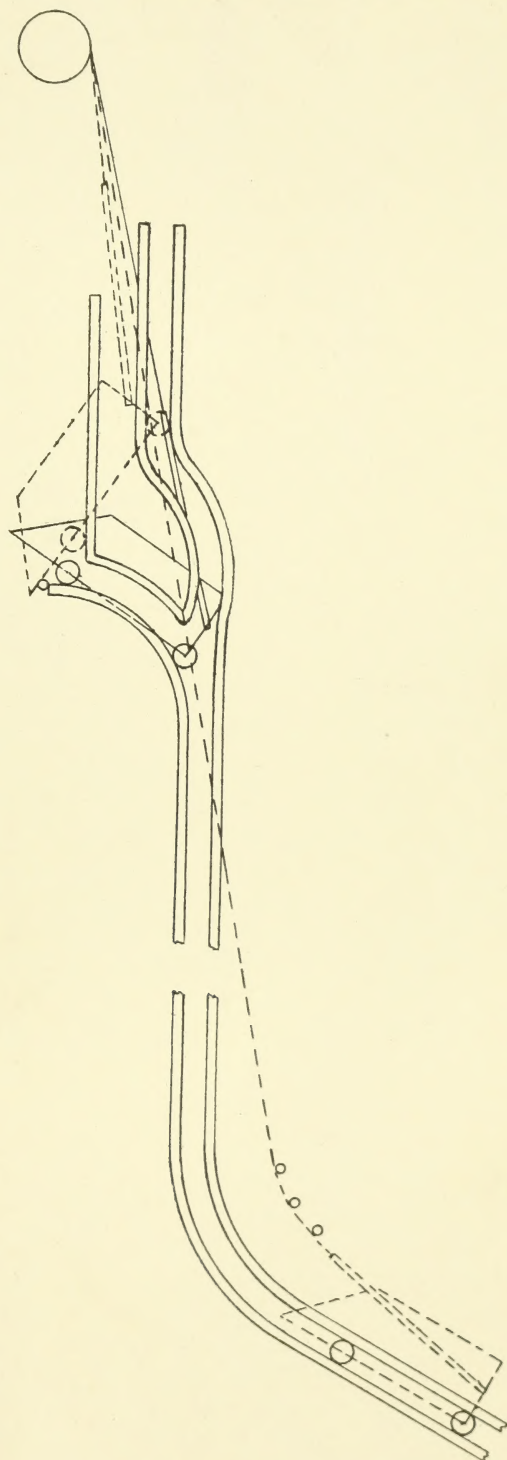
Many of the mines in North Carolina are based upon more or less flat veins, and since most of the ore is hoisted in buckets, it is customary to sink vertical shafts. When the mines become deep, this requires expensive cross-cuts to reach the vein; hence there are many vertical shafts which are turned upon reaching the vein and not adapted to the use of a cage or an ordinary style skip. Mr. George E. Price has overcome this difficulty at the Rudisil Mine, at Charlotte, Mecklenburg County. The skip and dumping arrangement are shown in the accompanying drawing, Pl. IX. The shaft is vertical for 200 feet and then inclines at an angle of 35° from the horizontal for 150 feet more. This skip is the ordinary iron skip, except that

the wheels are a little larger than usual, to reduce friction on the incline, and all have narrow treads. In the vertical part these wheels run between two vertical guide timbers. The rope is not over the center of the shaft, but toward the dumping side, so that when the skip reaches the top the front wheels run down the forward curve of the track until they strike the stop shown. Then the rear wheels swing to the rear in the arc of a circle as shown. Just before they reach the top of this arc the nose of the skip strikes a roller which raises the front wheels sufficiently to bring them to a bearing against the front vertical guide, so that, in case of overwinding, the skip rises at the dumping angle and rock cannot be dumped down the shaft. In this way the skip need wait at the top of the shaft only long enough for the ore to slide out of it, which is but a small fraction of a minute.

The ore is dumped from the car on to a platform, about 3 feet below the level of the rails, and the skip is stopped with its top about level with this platform and nearly filling the opening in it. If the output of the mine was a little greater, Mr. Price would replace the platform by a small bin, into which the cars could be dumped as they reach the station, and from which the ore could be rapidly run into the skip through a chute. But since the man that would be required to operate the gate has ample time to shovel all the ore into the skip, there would be no labor-saving in the bins and no justification for the expense. For even a small mine this skip saves the labor of a top man.

In the ordinary vertical shaft the bales of the skips are fitted with shoes, and there are no wheels on the skip, which is unlatched and dumped at the top by rollers striking suitable curve guides. Such a skip has the advantage of needing only one set of guides and no wheels, but it cannot be operated around a curve.

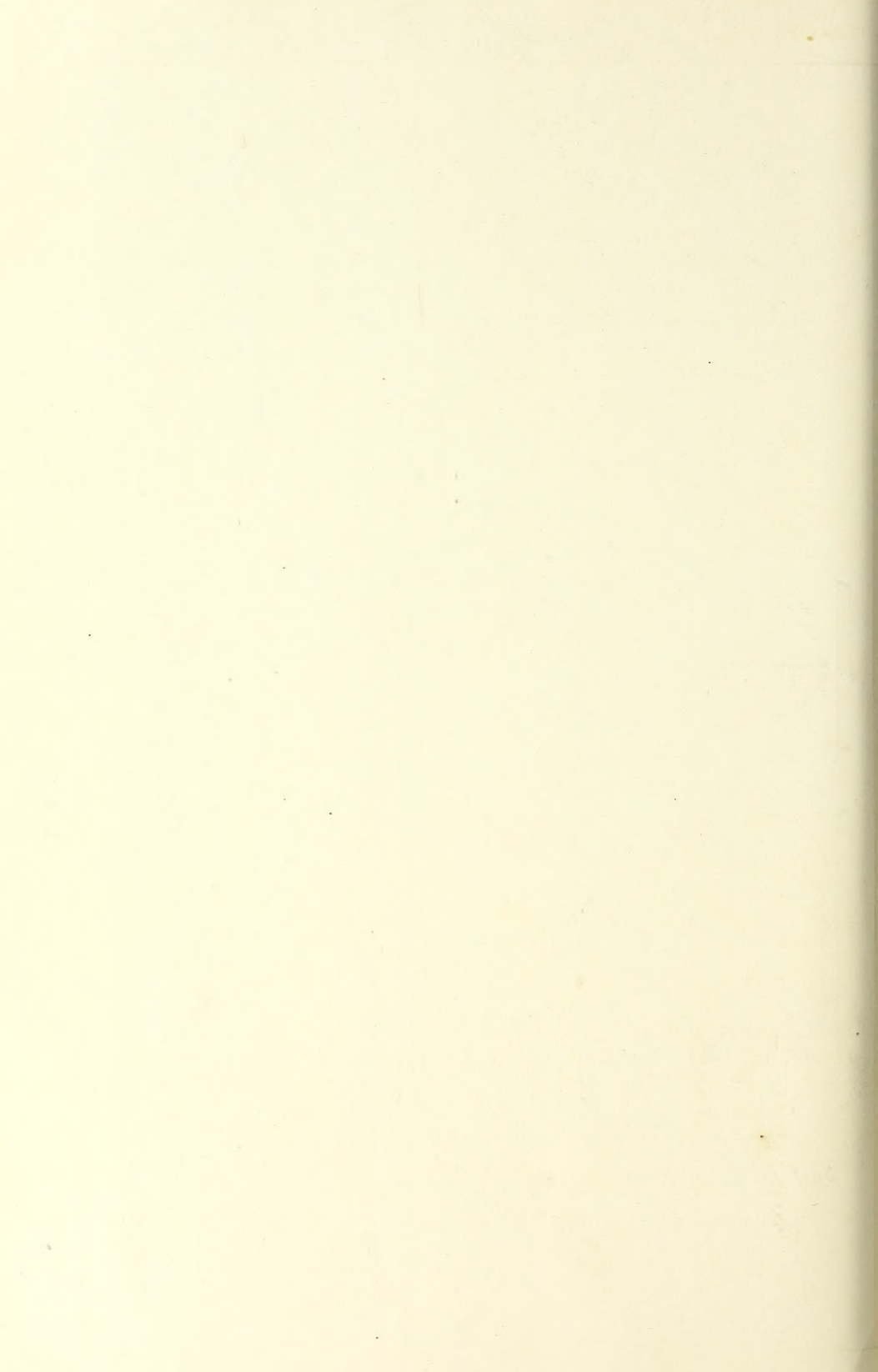
The labor of the top man is also avoided by a self-dumping bucket, observed at the Blackmon Mine, South Carolina. As shown in the drawing, Pl. X, this is an ordinary bucket fitted with guide wheels. The back wheels are caught by a latch at the dumping-place and it turns over when the rope is slacked off. Then the bucket is raised, the latch is withdrawn by the engineer and the bucket lowered.

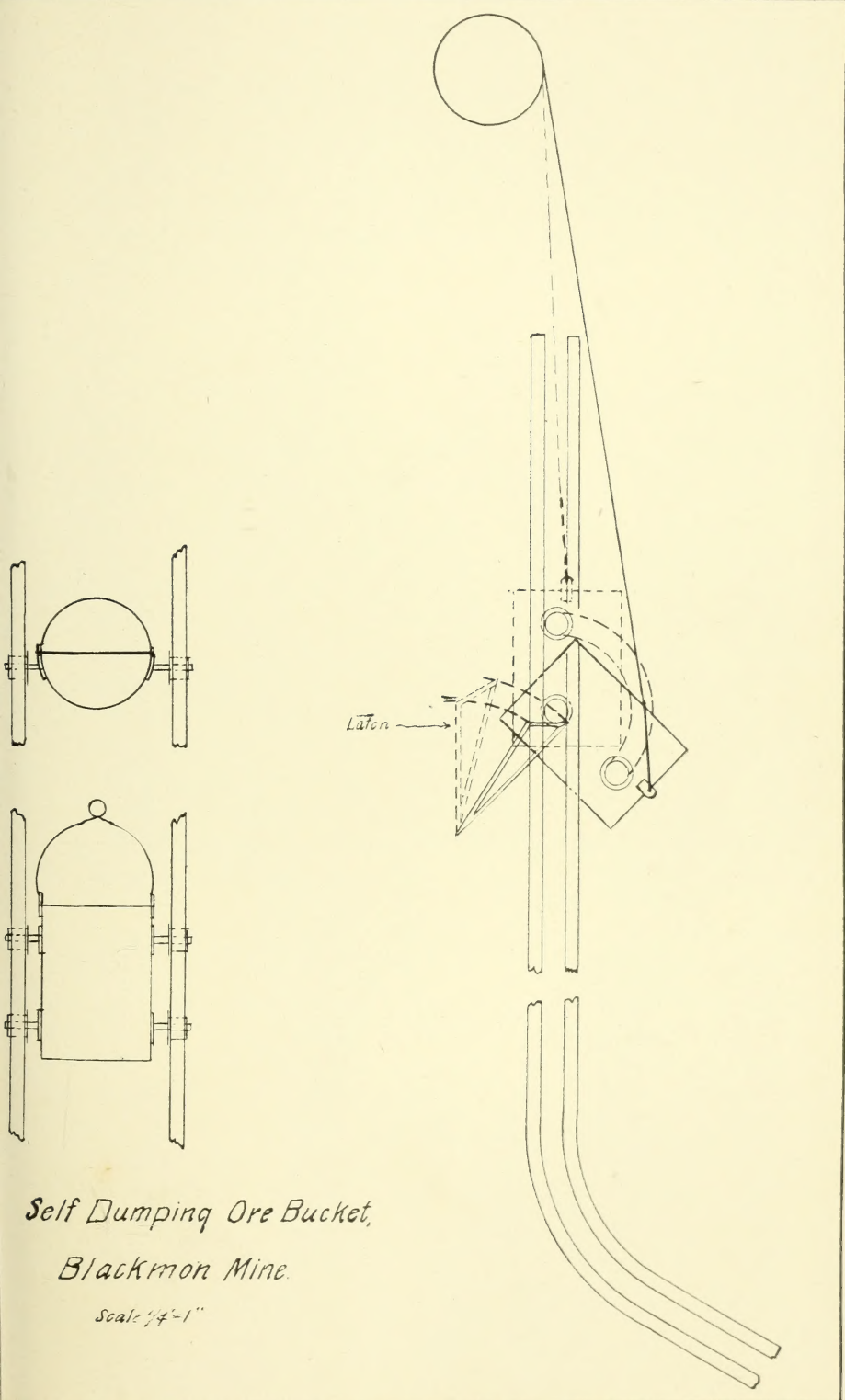


Self Dumping Skip

Rudisil Mine.

Scale 1" = 1/8"





DESCRIPTIONS OF ORE DEPOSITS AND MINES.

In the following pages are given descriptions of the gold mines and ore deposits examined during 1906. Where these are thoroughly described in Bulletins 3 and 10, and nothing new has been developed since the publication of those reports, no detailed description is given, and the reader is referred to these two bulletins.

BOYLSTON MINE.

This mine is situated on the southeastern slope of Forge Mountain, on the waters of Boylston's Creek, 22 miles south of Asheville and 12 miles west of Hendersonville. The ore deposit and occurrence are very fully described in Bulletin 3, pages 181-191. The four veins described in Bulletin 3 have not been continuously determined, except for some 2,500 feet on vein No. 2. Vein No. 1 was observed where it had been opened by a 15-foot incline, which shows here about 30 inches of pretty sharply defined vein quartz on the north side, at the top of the shaft, with a pay streak 6 to 8 inches wide near the center. A short distance each way the lens is smaller, and a 40-foot vertical shaft on the hillside just above was stopped at water-level without having cut anything of value.

This mine is still in the prospect stage, and much more work must be done to prove that the ore-shoots are continuous enough to be mined profitably at greater depth. There are a great many springs along the side of the mountain, and the water-level seems to be unusually close to the surface.

MINES NEAR HARTLAND.

At Hartland, Burke County, begins a long series of mines which have been opened along a diabase dike, partially altered to serpentine, which is described in Bulletin 3, page 176. Close to Hartland is the Hercules Mine, owned by Robert Orr and others. On this property there are about twenty distinct veins, from a few inches up to a foot or two wide, but these are 30 feet or more from each other, so that they cannot be worked together. There are a great many small shafts that have been sunk at different places on these veins, and eight of them are 60 to 70 feet deep, reaching water-level. The ore taken from this lower depth shows a little chalcopyrite, galena and very fine-grained pyrite. It looks as though the ore could be very easily concentrated—probably six or eight into one.

The old McKenzie is next on the line and was worked by the Blue Ridge Mining and Milling Company, which installed a steam hoisting pump and sunk a rather large vertical shaft to a depth of 68 feet on the hill near a road. It also erected a 5-stamp Mecklenburg mill in the hollow near the vein. Although considerable money has been spent on this property, the work has not demonstrated its actual value. It would seem that the property could have been proved up quicker and more economically by an adit along the vein. There is a number of small quartz seams or veins that are rich in gold, and saprolites carrying small amounts of gold.

The next mine is the Paxhill Mine, which was prospected in 1905 by a miner from Montana; but, according to his report, he was unable to find sufficient ore in the vein to make profitable mining.

At the Johns River is the Baker Hill Mine, which for the past year and a half has been under the direction of Capt. Eugene Mayne. The so-called main vein is along the crest of the hill, and the company owns it for a little over 2,000 feet. The principal shaft shows the vein 18 inches wide at the top and 5 feet at a depth of about 110 feet. It is a very hard quartz, somewhat fractured, and coated with a good deal of stolzite and pyromorphite. In mining, the different sorts of ore were kept separate and tested in the McKenzie mill. The No. 2 shaft was 42 feet deep and is near the serpentine dike. Near the surface this showed seven small, nearly vertical seams of quartz, which united near the bottom of the shaft to form a body 2 feet thick. On the east side of the hill are thirteen small shafts or pits, about 30 feet apart, which have been sunk on a hard, white, solid quartz vein, almost uniformly one foot thick.

At the bottom of Baker Gulch, opposite the No. 1 shaft, is a 4 x 6-foot cross-cut tunnel, which is being driven to cut the vein exposed in No. 1 shaft. It is now (August, 1906) in 210 feet and will cut the No. 1 shaft at 315 feet and at a depth of 140 feet. At the mouth of Baker Branch, on the Johns River, is a 40 horse-power locomotive boiler, supplying water to a 7-inch line for hydraulicking in the bed of the creek of the old workings. The hydraulicking was unsuccessful on account of the irregular grade of the sluices and other work done before the coming of Captain Mayne; but it will be taken up again under Captain Mayne's supervision.

The property, while largely a prospect, offers possibilities that make it worthy of further development work.

SHUFORD MINE.

This mine, which is owned by the Catawba Mining Company, is described on page 21. Before the installation of the Modern Pulverizing and Concentrating Machine at this mine, considerable work had been attempted by straight hydraulicking, but failed because it was impossible to save the gold. From the old cut, which was approximately 200 by 600 feet and 10 to 20 feet deep, a deep outlet sluice was dug to a splendid settling pond about half a mile away. With, however, the introduction of the modern washer, they have been able to save the gold at a profit.

BEAVER DAM MINE.

A recent attempt was made to mine this old placer by the Modern Pulverizing and Concentrating Machine, since previous operators had been troubled by clay-balls when they attempted to hydraulic it. At the time of the investigation the plant was shut down and partly dismantled. Mr. William Griffiths, of Scranton, Pa., the engineer who was in charge, stated that for some unknown reason the machine failed to save enough gold to pay expenses.

DEEP RIVER MINE.

The Deep River Mine is about 4 miles northeast of High Point. It was abandoned early in 1905 by the Coronora Mining Company and bought at sheriff's sale by Johnson R. Redding, a furniture man of High Point. Information was obtained from Mr. J. A. Allred, who was surface foreman and practically superintendent. The main shaft is 200 feet deep, and at the 80-foot level there is a cross-cut 44 feet long (to the west) to the vein, and then a drift 200 feet north to the old shaft, and another 30 feet to the south. This level shows a thin streak of oxidized ore, "brown ore," and a 5-foot vein of slaty quartz, with some pyrite. At 100 feet there is a 20-foot cross-cut to the vein which dips at about 45° . On this level is a drift 230 feet to the north; at about 150 feet the shaft cuts the vein and shows 12 feet of quartz, with pyrite and chalcopyrite. The last company never unwatered the part below this. The quartz is said to have been worth about \$10 a ton and to have yielded concentrates worth \$40 to \$60 a ton, which were shipped. They shipped some rich sulphide ore that assayed \$30. On the 100-foot level, in the early days, there was a 5-foot body of oxide ore on the 100-foot level that went \$200

a ton, but this was quickly exhausted. The Coronora Company mined the sulphide ore left besides this, which was amalgamated and concentrated. The thickness varied from 18 inches to 12 feet and averaged something like 8 feet. It yielded \$5 to \$6 a ton in gold and 2 to 3 per cent. copper. There is said to be good ore at the ends of the drift. The ore on the dump is hard quartz, with chalcopyrite and limonite and some muscovite. The country rock is a very micaceous schist.

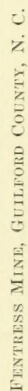
There is a second vein on the Deep River land some thousand feet north of the first. There is a caved-in inclined shaft, said to show a vein dipping 45° , which increased from 8 inches at the top to 5 feet at a depth of 45 feet.

THE HIGH POINT MINE.

This is 2 miles southwest of town and shows a bold outcrop of a lenticular mass of bull quartz over 10 feet thick at the center and dipping 45° . Quite a little work has been done, but, except a little picked ore showing chalcopyrite and limonite, the dumps look very barren. The last work, 20 months ago, showed that this ore would not pay the bare milling expenses.

FENTRESS MINE.

The Fentress Mine, situated about 9 miles south of Greensboro, has recently been reopened by the Century Development Company, of New York, under the direction of Paul J. Paulson, Ph. D., Leipsig. At the time the mine was visited they were milling profitably an old dump of copper slag for gold. The vein consists of a number of stringers in altered and decomposed granite, and not a solid vein. The stulled material is probably the granite, etc., from between the stringers; but since it was worked in the early days for copper only, there may be good gold values. The workings to the south from the new shaft show a fissure that is very narrow in places, and the best part has been stoped out, as shown, but there are some good-looking bunches of quartz and siderite left. At the time of my visit some miners were working to the north of the new incline, following a very small fissure of quartz in the foot-wall. In the lower levels the values are chiefly in pyrites, and there is almost no copper. There is one 3-inch streak which Dr. Paulson says assays 5 ounces per ton (\$100 in gold). Dr. Paulson is a very careful and conservative manager, and the work is being well done. See Plate XI.



They will crush the ore in the 10-stamp (840 pounds) mill, amalgamate the free gold and concentrate; reject the tailings, leach the copper from the concentrates (estimated at 7 per cent.) by a 2 per cent. solution of ammonia (NH_3), by a method of Dr. Paulson. The tailings from the copper treatment will then be cyanided for gold. The tests for this were not complete and he did not know what strength would be used. The unusually strong $\frac{1}{2}$ per cent. solution gave an extraction between 98 and 99 per cent.

Mr. J. M. Hendrick and associates, of Greensboro, have just incorporated the Twin Edwards Copper Company, to wind up the estate of A. L. Gilmer. The mine had been worked a little before the war, and the first payment on an \$80,000 sale was made just before the war stopped all operations. No work has since been done.

Mr. Jones, now of the Iola Mine, and associates, spent some little money opening the Palachian gold and copper mine, some 10 miles from Greensboro. Very little was found and the mine was abandoned early in 1906.

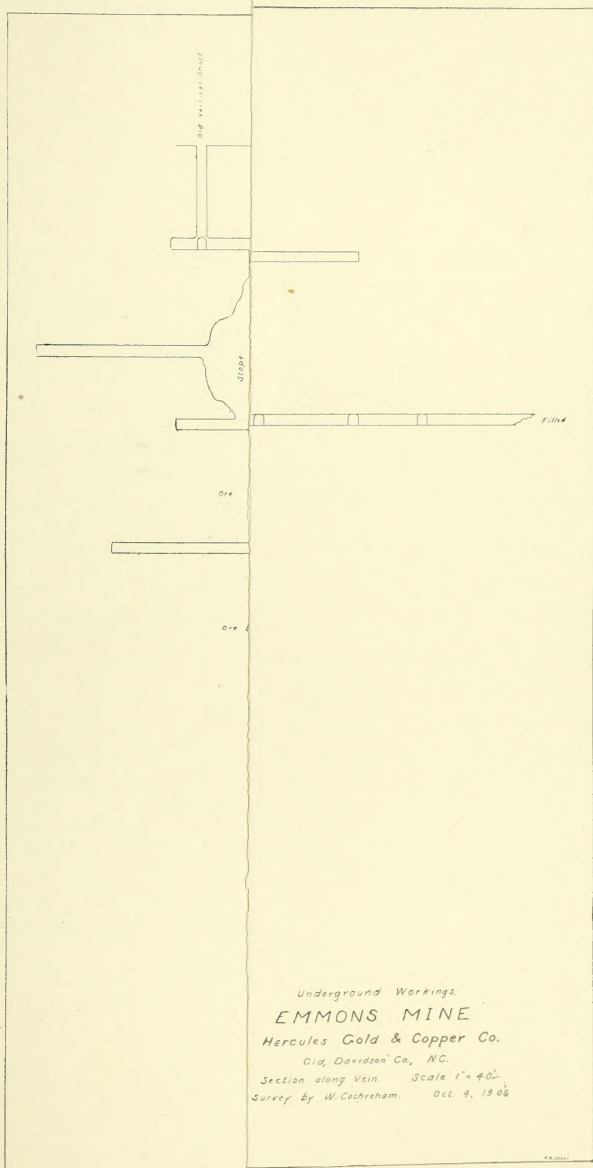
EMMONS MINE.

At Cid the Hercules Mining Company is working the old Emmons Mine, under the direction of Mr. W. Cockreham, a Joplin miner. The longitudinal section of the workings up to July, 1906, is shown on the accompanying map (Pl. XII). The vein is as described in Bulletin No. 3, page 60. Mr. Cockreham has deepened the shaft and driven the bottom level, and has put up a raise to connect with the other shaft. He is getting ready to drive a level below, and so he is developing a little faster than he is stoping, in anticipation of running the mill twenty-four hours per day.

The vein is parallel to the slates and consists of irregular stringers of quartz, often cutting into or surrounding masses of slate. These carry considerable chalcopyrite and pyrite, sometimes mostly one, and sometimes the other. The included and adjoining slates are also mineralized, but there is usually but little chalcopyrite outside the last ribbon of quartz, but sometimes there is very little quartz in the vein. Mr. Cockreham thinks that the gold follows the quartz. There is no selvage along the walls, and at least one of them is very irregular. The ore is generally 2 to 3 feet thick, but in one place it is 12 feet, and the vein is often very narrow. There is no ore south of the main shaft, and the richest shoot is the one that has been continuously stoped, just north of the main shaft. The widest one is just beyond

the north or No. 2 shaft, and there is a very long body of ore on the 200-foot level, reaching nearly from shaft to shaft. There is ore in the No. 2 shaft to within 30 feet of its bottom, where it becomes lean and quartz. Most of the 275-foot level is barren beyond the main shoots, although there is some ore in the upper part of the up-raise. On this level the main shoot is not quite so long or so wide, but is a little higher grade. In the breast of this level there is a little ore in quartz, and Mr. Cockreham will continue this drift as soon as the No. 2 shaft is holed through. The ore, mined chiefly from the good shoot, runs from 3 to 4 per cent. copper. The No. 3 shaft is 170 feet deep, on a sharply defined 30-inch quartz vein, some 300 feet in the hanging wall. There is almost no drifting, but Mr. Cockreham thinks the vein is a good, strong one, and is anxious to drift in search of ore shoots. The same company also owns the Cid Mine, apparently the northern extension of the No. 3 vein. There is an inclined shaft 110 feet deep. On the dump there is milky quartz, containing a good deal of chalcopyrite and bornite. Mr. Cockreham says the vein is 29 to 30 inches wide, and he will develop it as soon as he has a little money ahead from work on the Emmons Mine. At a depth of 50 feet is an old diagonal drift, driven in search of gold. Although the shaft is 12 x 6 feet, there has been but 40 feet of drifting on the vein.

In the Emmons Mine all the ore is mined by underhand stoping, blasting the ore to a chute at the foot of the winze, so that all the waste, which must be broken where the vein is narrow, has to be hoisted, and the rather shelly roof must be supported by thickly placed stulls. This is done because the farmers who are employed as miners cannot drill uppers. Where the rock is hard, they have the good arrangement of two strikers for one man turning the drill. On the 200-foot level in the old overhand stopes the ore was allowed to drop to the floor of the level and then shoveled into cars, instead of the better system of chutes and lagged stulls to support the waste. The mine is equipped with a Cornish pump, except for the lowest lift, from which the water is taken by a steam sinking-pump. The mine is not very wet. Mr. Cockreham has installed a Michigan skip, operating in the 48° shaft, with a special car for lowering the men. They have a 10-drill air compressor, and generally use air-drills, but are now doing all of the work by hand, on account of the price of cord-wood. Mr. Cockreham is burning coal, which now costs \$4 per



ton delivered at the mine, and so is more independent of the cordwood supply. At the top of the shaft all of the ore is washed with a hose and the pieces of slate picked out.

At the mine is a fine blast-furnace smelter and accessories which have never been used. Afterwards they put in a 10-stamp concentrating mill, with two Wilfley tables. (Pl. XIII, A.) Mr. Cockreham has ordered classifiers and more Wilfleys, so that he can separate fine ore from the middlings, reconcentrate and regrind the middlings. When this is done he will run the mill two shifts and take samples of ore and tailings. The concentrates have been shipped to W. E. C. Eustis, of Norfolk, but he will send the next lot to the Nicholas Chemical Company, Laurel Hill, L. I. A representative carload of concentrates gave smelter returns: 7.7 per cent. copper, 1.27 ounces silver per ton, and 0.10 ounce gold per ton, for which they paid \$31 per ton, and charged \$12.80 a ton for smelting and sampling. A carload of selected ore from the mine went 9.2 per cent. copper, 2.6 ounces silver per ton, and 0.06 ounce gold per ton. Drifts cost from \$5 to \$6 per foot when driven by hand on contract, the company furnishing powder and tools, and only \$2.50 per foot when driven by machines, when the company furnishes air and tools only, contractor furnishing powder, etc. Winzes cost \$5 per foot under the same conditions.

LAFFLIN MINE.

The old Lafflin Mine, near Cox, Randolph County, $4\frac{1}{2}$ miles east of Cid, is being worked by the Empire Mining Company, under the superintendency of Mr. O. K. McCutcheon. The property was thoroughly sampled in cross-cut trenches, etc., by Mr. McCutcheon and Mr. Gaiford, who worked for 14 days with two assistants and made careful pan assays. This work showed that gold occurs in two belts, about 200 feet wide, and a half mile long. These consist of argillaceous slates full of casts of pyrite quite uniformly distributed along the bedding plane. They do not seem to be at all silicified, although the one on the southeast is limited on the north side by hard quartz and siliceous slate veins; and an old tunnel on the other one cut a sharp quartz vein carrying about \$8 in gold per ton. At the north end of the southeast one is a lot of old open cuts, one of which shows a sharply defined 8-inch stringer of bull quartz. There are several tunnels in this old Kern Hill which show

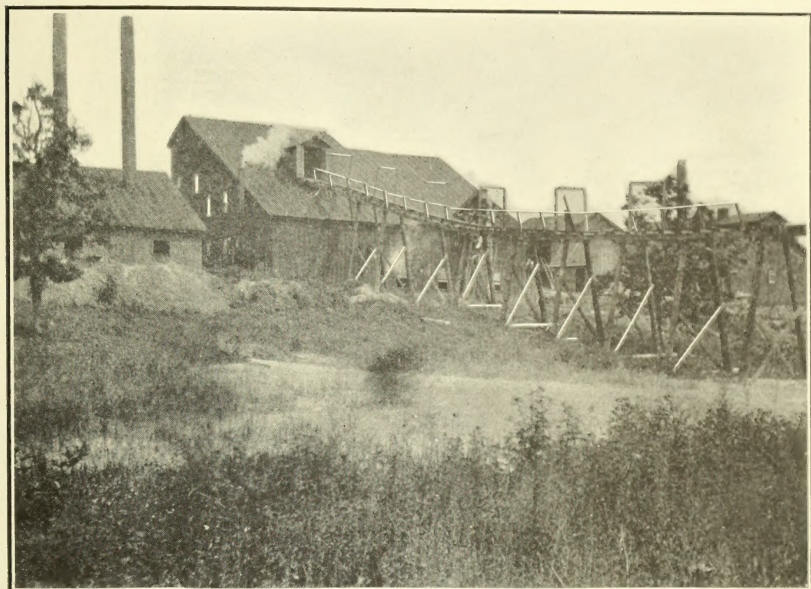
the slates to be soft to a depth of several feet. At the north end of the other lead is a large, open cut, some 75 feet across, and formerly 50 feet deep, but now partly filled. This was opened by a tunnel from below and contained \$6 or \$7 ore. The northeast corner of this contains some very irregular workings which followed rich ore, now all worked out. At the present level is a tunnel some hundred feet long. A cross-cut from the left of this cuts the hard vein already mentioned; one to the right, some 50 feet long, does not cut through the slates which all the way pan \$1.50 per ton. Below the hill, at the side of a little gulley, is another deep cut which shows that the zone is some 200 feet wide. These all show that the slate is soft to a depth of 50 feet or more, though not so soft as on Kern Hill.

The company has installed one double unit of M. P. & C. machines at the southwest end of this southeast body (opposite the large open cut), as described on page 22.

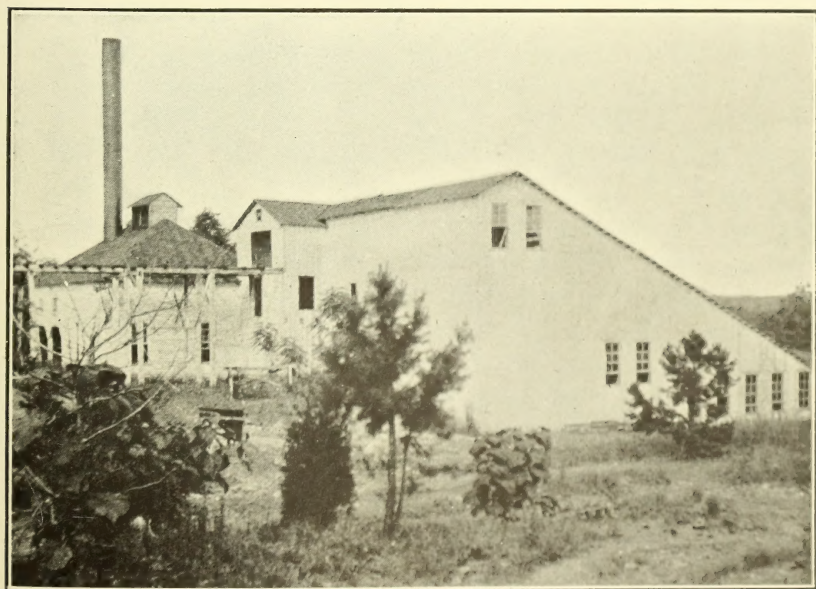
Mr. O. K. McCutcheon, of the Empire Mining Company, is talking of installing M. P. & C. machines on the old Belt tract of 229 acres, parallel to the Empire Mine, on the north. He claims a half-mile zone of ore worth \$2 per ton, but there are some portions of the area for a distance of half a mile where I failed to get any colors at all in panning samples of the soft rock from the bottom of a couple of long cross-cut trenches. At the southwest end the old workings are more extensive and the dumps show a little gold in the pan.

SAWYER MINE.

This mine is 5 miles west of Sophia, but is best reached by team from Ashboro or High Point. W. J. Kerr, E. M., Lehigh '81, is general manager, and R. I. Dickens, superintendent. The country rock is a glistening sericitic quartz schist. The accompanying sketch, Pl. XIV, illustrates the vein. The Miller vein is simply a more siliceous and enriched zone on the hanging wall side of a dark granitic porphyry (diabase), from which it is separated by a darker zone of schist forming a sharply defined wall of the vein. There is no hanging wall, but simply a diminution of the mineralization of the limonite. The mineralized part of the zone is 6 to 50 feet thick and will probably average 15 feet for the whole length. Careful sampling by Mr. Kerr gave an average value for the hard rock of \$6.10 per ton in gold. There is a recent vertical shaft, 150 feet deep, cutting the



A. MILL AND SMELTER, EMMONS MINE, DAVIDSON COUNTY, N. C.



B. CONCENTRATING MILL, GOLD HILL COPPER MINE, ROWAN COUNTY, N. C.

vein at 100 feet, and the trap dike at 110 to 120 feet. At the 100-foot level are drifts 40 feet each way. The sulphides begin at a depth of 80 feet and concentrate so well that the tailings only carry about 20 cents per ton, although the pyrites is very fine-grained, say 60 mesh, and occurs in little bunches or specks. In the wall rock it occurs in cubes up to one inch on a side. The hard granitic-looking rock from the shaft slacks in the air. This vein was opened for a mile and a half along the outcrop before the war. Near the main shaft are some new workings; one quite extensive new open cut carries specimens showing visible gold in considerable quantities. A sample was taken along 4 feet, which gave in assaying a value of \$14 per ton. This is soft sericite. At other places the vein is hard laminated quartz like the ore bodies in the Russell Mine. Across one opening, 22 feet wide, there is a very careful sample groove which shows how carefully the mine was sampled. Most of the old workings are caved or full of water and were not examined. The Davis vein is a 1200-foot loop separated from the main vein by a 240-foot horse including the dike. Where the two unite at the northeast end is a body of \$6 ore 32 feet wide. The supposed junction at the southwest end has not been found. At the tramway cut the vein shows 11 feet heavily stained with limonite which repeated assays have shown to average \$4.20 per ton. There is a shaft just west of this cut with a tunnel along a cross vein, but that ore was not much richer.

The soil in the space between the Miller and Davis veins was found to average \$1.69 a ton by careful sampling in small test pits. This will be worked first in the M. P. & C. machine as described on page 25. The Sulphur vein is parallel to the Miller some 600 feet southeast. Near the old mill it has been opened to a depth of 60 feet and stoped to the surface for a length of 100 feet. At the surface the vein has a width of 22 feet, of which the richer 6 feet only are stoped. This averaged about \$9.20 a ton and gave 50 per cent. concentrates, chiefly pyrite. The average of about 75 samples of the leaner 16 feet was \$2.80. Where a small road crosses the vein some distance from the stope it shows 7 feet worth \$0.80 to \$1.20. Across the main road are old workings on the Sulphur vein 6 feet wide, about 150 feet long and 30 feet at the deepest place. These workings were based on some rich limonite and there is said to be still a 6-inch streak of limonite in the bottom worth about \$100 a ton.

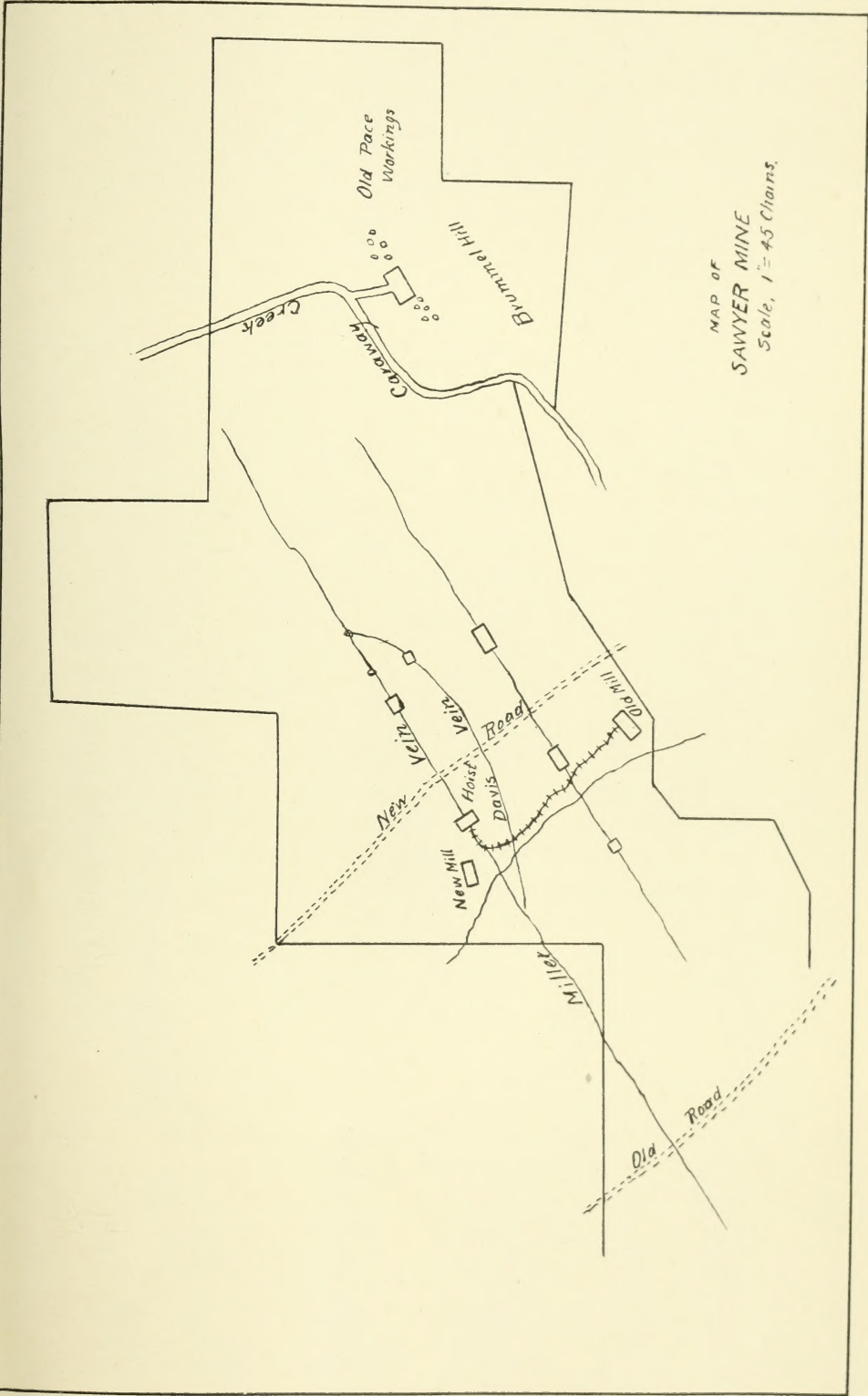
The Brummel Hill workings, which may be on an extension of the Sulphur vein, but probably are not, were worked extensively by a number of small owners operating Chillian mills on the creek below. Some of the shafts are very deep but are full of water except during dry spells. For 450 feet next to the creek the zone of irregular workings is about 40 feet wide, but the bodies are somewhat irregular and walls are only shown by the disappearance of the gold. In places both the vein and the country rock are very hard and siliceous, resembling quartzite. At the far end of this wide zone is a large open cut next to a trap cross-dike; 100 tons taken from this gave \$2.50 per ton on the plates. The vein dips nearly 45° and the old Pace workings on the high hill beyond are, therefore, considerably out of line and may even be on a separate vein. Here there is a 6-foot vein which carries \$9 ore for intervals of about a half-mile to the northeast. There is a number of trap dikes cutting across the country as well as parallel.

At the time the property was visited the company was installing an M. P. & C. machine to work the soil, disintegrated rock, etc., and later the hard rock, after crushing it by rolls. If this work succeeds on the soft sericite rocks they will test the wide, hard rock on Brummel Hill.

REDDING MINE.

This mine is 5 miles east of Ashboro, on the road to Cedar Falls. It is being worked by Mr. H. C. Robertson, R. F. D. No. 2, Randleman. Since March 1st, 1906, he has been opening up an old shaft in the creek bottom, and sinking on a $1\frac{1}{2}$ to 6-inch white quartz seam, carrying a little chalcopryrite and a few coarse nuggets of gold.

The country rock has the appearance of a black quartz porphyry, but is somewhat laminated and is probably a gneiss. It is cut in all directions by these very thin seams of nuggety quartz. The two miles of creek to Deep River were very rich in coarse placer gold, all derived from this small basin at the head. The shaft in the bed of the creek is down 55 feet and they are following a wide place on the stringer with a drift some 10 feet long (August, 1906). The vein in the breast is still 6 inches wide and looking good. The rock is extremely hard and progress is slow, although five men are employed. At the time of the visit the shaft was full of water from a recent cloud-burst.



SAWYER MINE, RANDOLPH COUNTY, N. C.

COL. A. C. McALLISTER'S PROPERTY.

Col. McAllister owns the Davis Hill Mine of 135 acres, 6 miles from Ashboro, containing half a mile of an auriferous belt. One of these shows a 60-foot zone of pretty hard oxidized slates with many lenses (18 inches by 10 feet or less) of coarser schist containing limonite cubes. This was prospected before the war at the top of a 75-foot hill by means of an open pit about 20 feet across and 30 feet deep with nearly vertical sides. Here, in places, the zone is very soft and sometimes sandy and also contains a good deal of white, vitreous quartz in large masses, speckled with mica. Within the year an unsuccessful attempt was made to hydraulic this. They have sampled only the limonite-bearing lenses, which are supposed to run \$3 to \$4 per ton. It is doubtful if the whole zone will average over \$1.50 per ton. Across a little branch is a 30-foot cross-cut trench 4 to 6 feet deep in the slates, which are nearly as soft as clay. This all pans some gold. The main zone connects with old workings on other property to the south, where it is said to be richer.

ALRED MINE (OLD BURNS).

This mine is owned by Mr. Harlan Page and no examination of the property was permitted. The unexplored north part of the property is now owned by the Sandy Creek Mining Company, 516 Pennsylvania Building, Philadelphia, Pa. The mining will be directed by Dr. E. Fahrig, Betz Building, Philadelphia. The preliminary prospecting has been done by digging trenches 6 feet deep and panning them. It is stated that all of the surface ground pans 30 to 40 colors to the pan, but that it is seldom that anything is obtained below a depth of 3 feet. One pan full of decomposed rock (clay) is taken from each end of each 20-foot trench at the bottom and another from the center, the colors are counted and the results reckoned as the average of the cut.

In the schists are zones of harder rock carrying limonite cubes, etc., and it is reported that these carry values, although the rest of the country rock did not. Most of the trenches are between these zones of harder rock. A mill has been erected to treat 50 tons of ore in ten hours. It contains a crusher (Blake) and a high gravity dryer, and a Kent mill for fine grinding. The ore will then be wet again and washed in a Fahrig washer.

SOUTHERN HOMESTAKE.

This mine is near Cox, Randolph County. The nearest railroad station is Cid, Davidson County, about 4 miles away, but the mine is best reached by team from Thomasville, 13 miles. There is one shaft 52 feet deep, which shows a 6-foot streak of \$4 ore below a sheet of diabase. On this they have drifted 8 or 10 feet. Besides this, there are two deep, cross-cut trenches and a small open cut. A "grassroot" tunnel to the main shaft has been started, but this shows nothing but the diabase. The cyanide mill, designed by Mr. Ernest Gaiford, has been previously described, page 33. Three different mill tests were made on a total of 150 tons of ore, three-quarters of which was taken from the trenches and open cut and one-fourth from the better ore of the shaft. This 150 tons averaged \$2 per ton, which would indicate that the ore from the open cut, etc., was worth only \$1.33 per ton. A recovery is claimed in the three tanks of 70, 80 and 83 per cent. respectively; the tanks, however, were only filled with 3 feet of ore, although they are 6 feet deep. There was nothing on the ground in shape for sampling and the material from the open cut panned very low and the gold from the decomposed trap dike was especially fine-grained. The mill was extravagantly built at a cost of \$24,000. It is now in charge of Dr. J. F. McNeely, of Munhale, Penn.

WHITNEY MINE.

The Whitney Company has opened up the Whitney Mine, formerly the McMakin, and Isenhour, at Gold Hill, Rowan County. They have two shafts about 800 feet deep, 350 feet apart, and another shaft toward the old McMakin workings about 300 feet deep. There are drifts on eight levels. The ore is quartzose between slate walls, but the dumps show a great deal of slate full of white quartz veinlets, and Mr. Hambley stated that there are sulphides in the slates along the vein, but these have very little value. The vein varies from 3 or 4 feet wide to 25 feet, and Mr. Hambley assumed an average of 14 feet. His engineer reported a million and a half tons of ore blocked out. As the vein was more definitely proved to be of value, the prospecting shafts were sunk larger so that they can be easily changed to three compartment shafts and the mine equipped for an output of 1,000 tons a day. Part of the vein is very low grade, less

than \$1 a ton, but this shows occasional rich spots and cannot well be left. In the more quartzose parts there are some rich shoots or lenses 50 to 100 feet across of as high grade as \$14 to \$16 per ton.

During the development work, ore from the various drifts and cross-cuts was tested in the old McMakin mill of 10-stamps with chlorination annex. Tests made of 4,950 tons gave per ton of ore: Free gold \$0.51 to \$38.75, average \$4.52; gold in concentrates per ton of ore \$0.10 to \$0.83, average \$0.34; gold in tailings per ton of ore \$0.31 to \$2.75, average \$0.83. The ore yielded from 1.83 to 12.87 per cent. of concentrates which had an average value of only \$4.17 per ton. Chlorinating the concentrates gave an average gold recovery from them of \$3.33 per ton and a loss in the tailings of \$0.84. The amount of gold amalgamated was 79.44 per cent., while that recovered from the concentrates was only 4.78 per cent. of the total value of the ore. They will, therefore, not bother with concentration, but merely save as much gold as possible by amalgamation. Cyaniding has not been investigated as yet, but will hardly pay on tailings which will be so low grade.

There was a special report for each mill test, naming the place from which the ore was taken, and all details. By careful sampling in the mine they have figured that the ore will give an average recovery of \$2.50 per ton, but in the same proportion as that tested. On the basis of 1,000 tons per day, Mr. Parker expects to mine the ore for \$1.03 per ton, transport it to the mill for \$0.12, and mill it for \$0.26, total expense \$1.42 per ton, showing an expected profit of a little over \$1 per ton. Of course this involves equipment for electric hoist and haulage plant, etc. They will use double deck cages since the slaty ore is expected to give trouble in loading skips. It was Mr. Hambley's intention to push the development work only fast enough to keep a half million tons of ore blocked out. He states that the vein can be followed on the surface for a distance of 2 miles, but it is very probable that there are a good many barren spots along this length, and at the north end at the old Isenhour workings there seems to have been a number of small, richer deposits pretty badly scattered. The whole mine was quite dry, especially at depth. Mr. Hambley and others said that the Isenhour vein was 9 feet thick and of good grade, and it is over 6,000 feet from the other workings. At the mine all the high-head frames and machinery are carefully housed in and everything in fine shape. The company also

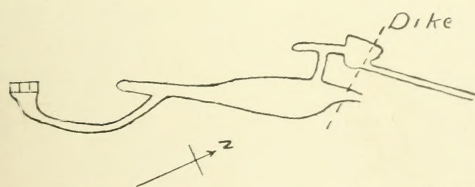
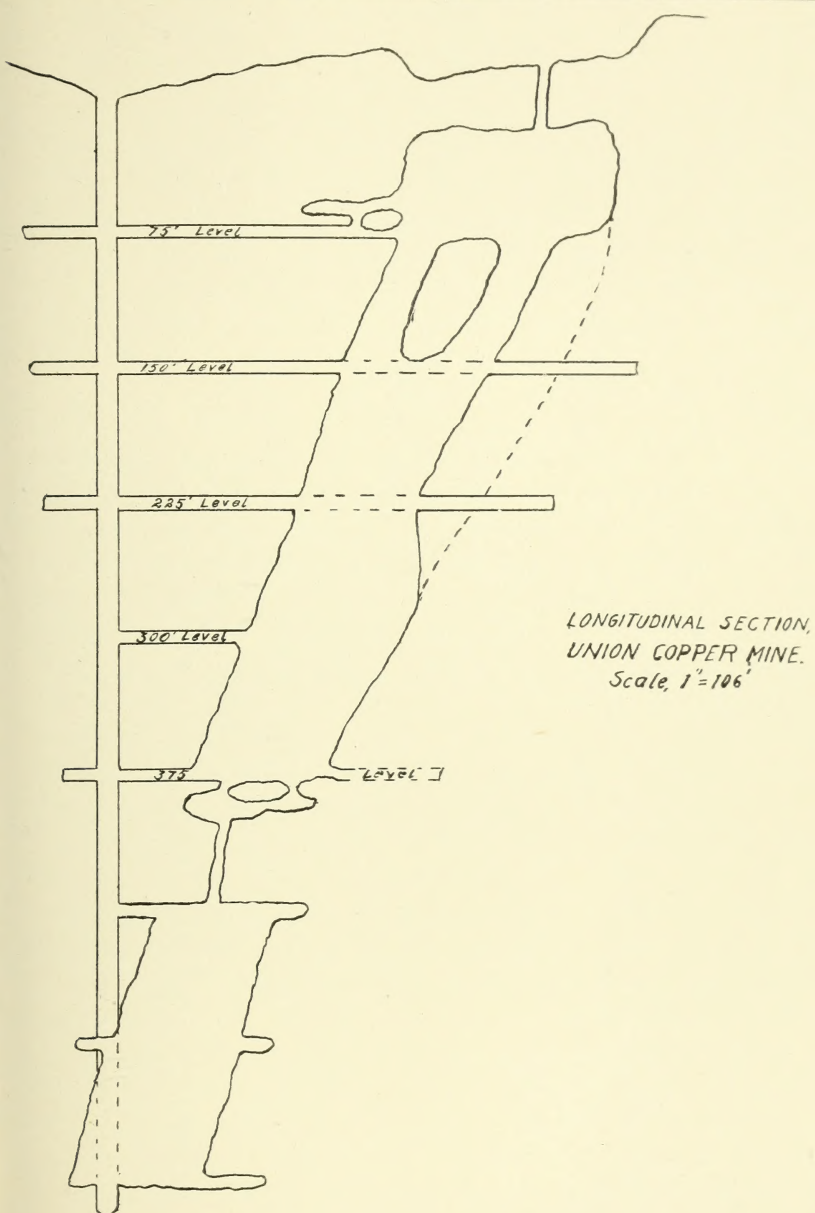
expects to take 50 tons a day from the Reimer Mine, 6 miles southeast of Salisbury. The mine was full of water at the time, and the mill burned down, so it was not visited. Mr. Parker reported the vein to average $3\frac{1}{2}$ feet thick and worth \$7.50 per ton. He estimated that it could be mined, hauled to the mill and treated for less than \$4.50 per ton. This agrees with the account given in Bulletin No. 3.

GOLD HILL COPPER MINE.

This mine, owned by the Gold Hill Copper Company, is located at Gold Hill, Rowan County. In the spring of 1906 the company's Barnhardt shaft-house and the Eames mill burned down, and at the time the property was visited, mining was being done through the Randolph shaft, with some stoping on the Big Sulphur and Texas ore shoots. On the 800 feet level a cross-cut was driven for a distance of about 400 feet, where it encountered some very rich ore, assaying, according to the superintendent, as high as \$750 per ton. This mine has been carefully examined by the State Geologist and Mr. F. B. Laney, and the results of the investigation will be published as part of the report on the Copper Deposits of North Carolina. The mill is shown in Plate XIII, B. The old workings have been described in detail in Bulletin No. 3, pages 87 and 88.

UNION COPPER MINE.

This mine, which is at Gold Hill, Rowan County, is now in charge of Mr. H. L. Griswold as superintendent, who is an expert Colorado miner. The main shaft has reached a depth of 600 feet, with eight levels. On the lowest level Mr. Griswold says the deposit was irregular and somewhat broken, so he has stopped sinking, but is exploring laterally pretty vigorously and stoping out the ore left on the upper levels. This particular mine was based upon a quartz lens, apparently replacing the slates, and below a large open cut. The quartz is mainly white, but contains black and grey streaks, apparently remains of the original slates. It carries a good deal of chalcopyrite, less pyrite, very little galena, and occasional bits of hornblende. The apparently unaltered ore, as shipped after some hand-sorting, carries about 4 per cent. copper, 2 or 3 ounces per ton of silver, and \$3 per ton in gold. Just below the water-level it is very soft, seems to be talcy or clayey, and carries up to 8 per cent. copper. The ore body seems to be at the intersection of two small veins and



southwest of a 4 to 6 inch trap-dike cutting across the slates. Both of the veins seem to strike a little more east than the slates, and break through zigzag. They are wider where the vein is parallel to the country rock. On the third level Mr. Griswold is following one of the veins, which is a clearly defined streak, 6 to 30 inches wide, toward the No. 4 shaft. He plans to do some exploring on various other veins as soon as he can obtain his company's consent to the leasing system.

The main ore body at the first sublevel is 130 feet long and 40 feet wide. Just below the fifth level it is about 100 feet long and something more than 15 feet wide in the middle, and the walls have not yet been reached. The accompanying longitudinal section, Pl. XV, shows the general situation. Under Mr. Newman's management the richer part of this was stoped out, including two chimneys above the first level. Mr. Griswold is now mining the leavings, as outlined elsewhere (page 27), blasting the ore off the sides of the old, strong stopes, but leaving sufficient pillars for safety and being more careful to protect the men in the bottom of the stope from falling rocks. He is working out the soft ore above by square sets. On the third level, as shown in the map, a very nice body of chalcopyrite was found on the northwest vein adjoining the small trap-dike. This body did not extend upwards any distance, but Mr. Griswold hopes that it will go down. This side vein is notable for carrying considerable calcite and more than the usual quantity of gold, and he is drifting along it to the north. At the time of the visit, there was from 18 to 24 inches of good-looking quartz, with pyrite and chalcopyrite between clay slips. Near the dike there was a smooth face across the vein, cutting off the good body of chalcopyrite, which was 8 feet wide and 15 feet long, but reached only 10 feet above the floor. On the other side of the dike there was 10 feet of low-grade ore which had not been stoped out. This same narrow vein shows a good honeycombed outcrop in the same relative position. In driving this drift Mr. Griswold will cross-cut at intervals to test for a continuation of the main vein and a little branch extending from this small bunch of good ore on the other side of the main part of the feeder. The ore is at present sold to the Tennessee Copper Company, which desires the quartz in it for fluxing purposes. Since this market is uncertain, the management is cautious in exploring for new ore bodies.

The old concentrating mill, with rolls, Bartlett and Wilfley tables, was not a success under the local labor conditions, and it and the local smelter are in ruins.

The drifts cost about \$8 per foot, including the expense of compressing air.

BARRINGER MINE.

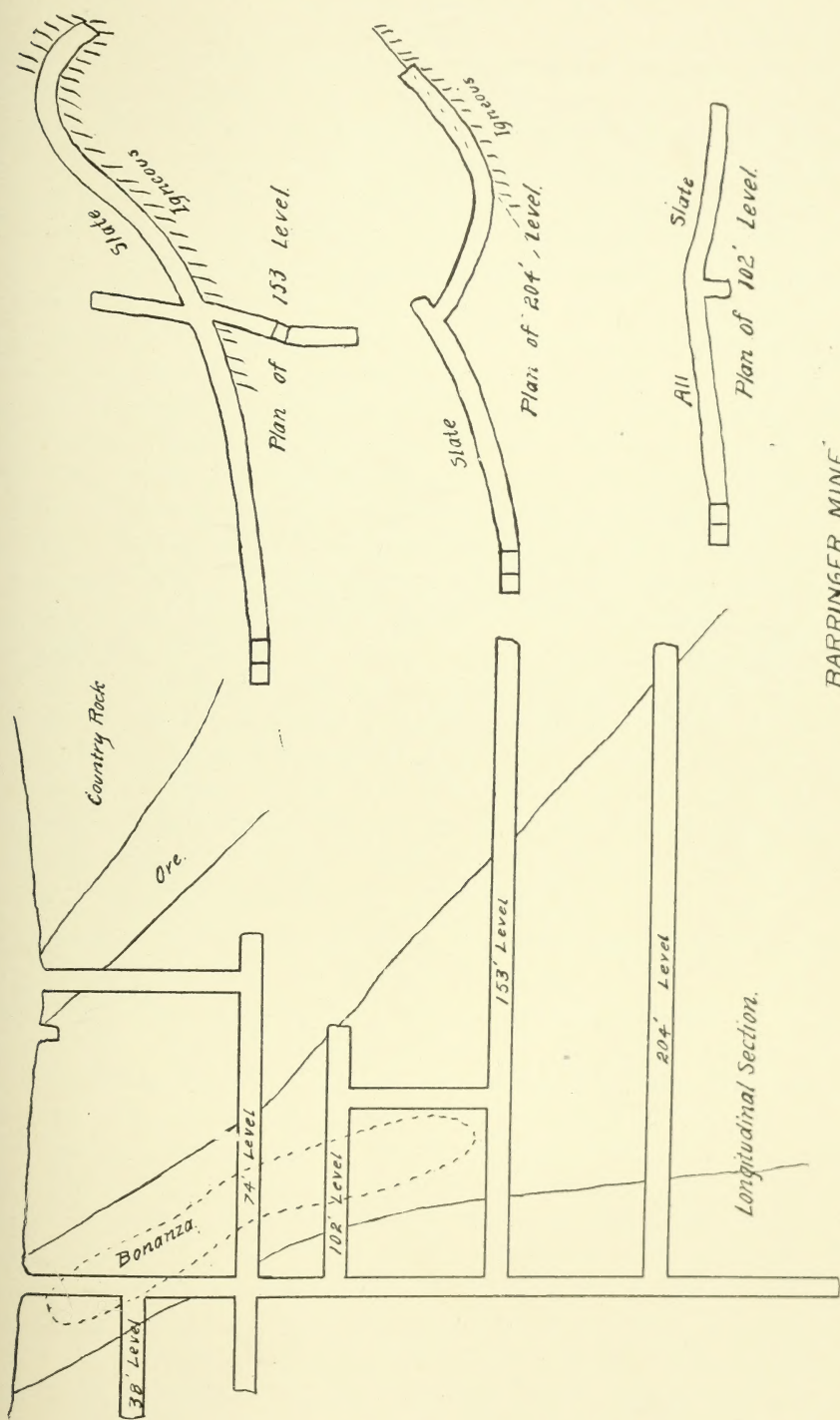
The Barringer Mine, which is located in Stanly County, 4 miles southeast of Gold Hill, is noted for the enormously rich ore that it has occasionally furnished. Some specimens from a 3-inch seam seemed to be 50 per cent. gold. This wonderfully rich ore came from a small shoot that was encountered near the surface, and extended nearly to the 153-foot level. See Plate XVI. It has been estimated that \$100,000 was taken from this shoot. A great deal of work was done in trying to find a continuation of this rich shoot, or another, but nothing of a similar character was encountered, and the mine was abandoned. The vein itself was rather wide, but the rich streak was extremely narrow. An idea of the difference in value of the two parts of the rich vein can be gained from the following assays: Gold, \$2.07; \$5.17; \$5.17; \$346.23; \$510.

A general idea of the underground workings of this mine is shown in the longitudinal section, Plate XVI.

One peculiarity of the gangue found in this vein is the occurrence of a large amount of calcite.

IOLA MINE.

This mine, which is owned by the Iola Mining Company, is 3 miles from Troy, the county-seat. The workings of this mine are shown on the map (Pl. XVII). The vein dips about 45° to the southeast and is parallel to the slates, striking N. 55° E. There are places showing 8 feet thickness of soft, white, "sugary" quartz, bearing \$30 per ton in gold, and other places with merely a stringer of quartz. The main shoot is from 100 to 150 feet along the vein, and continues from the surface down to the lowest level, 320 feet on the incline, without diminution, although the values are probably a little lower grade. Besides this, there are also several smaller shoots, generally about 30 inches thick in the middle and something like 30 feet in diameter. Some of these are the same sugary quartz, without visible gold, and some are hard, vitreous quartz, with included bits of altered slate. Along the contacts with the included slate are found coarse



BARRINGER MINE.
Scale 1"=60'.

gold crystals (octahedrons), up to $\frac{1}{4}$ inch through. But this generally mills only \$12 to \$15 a ton. There is a great deal of the vein as yet unexplored, and one other vein was found under the trestle from the mine to the mill, and still another under the cyanide plant. These have not been touched. A recent very heavy rain flooded the mine to the old incline shaft, so the bottom level could not be reached.

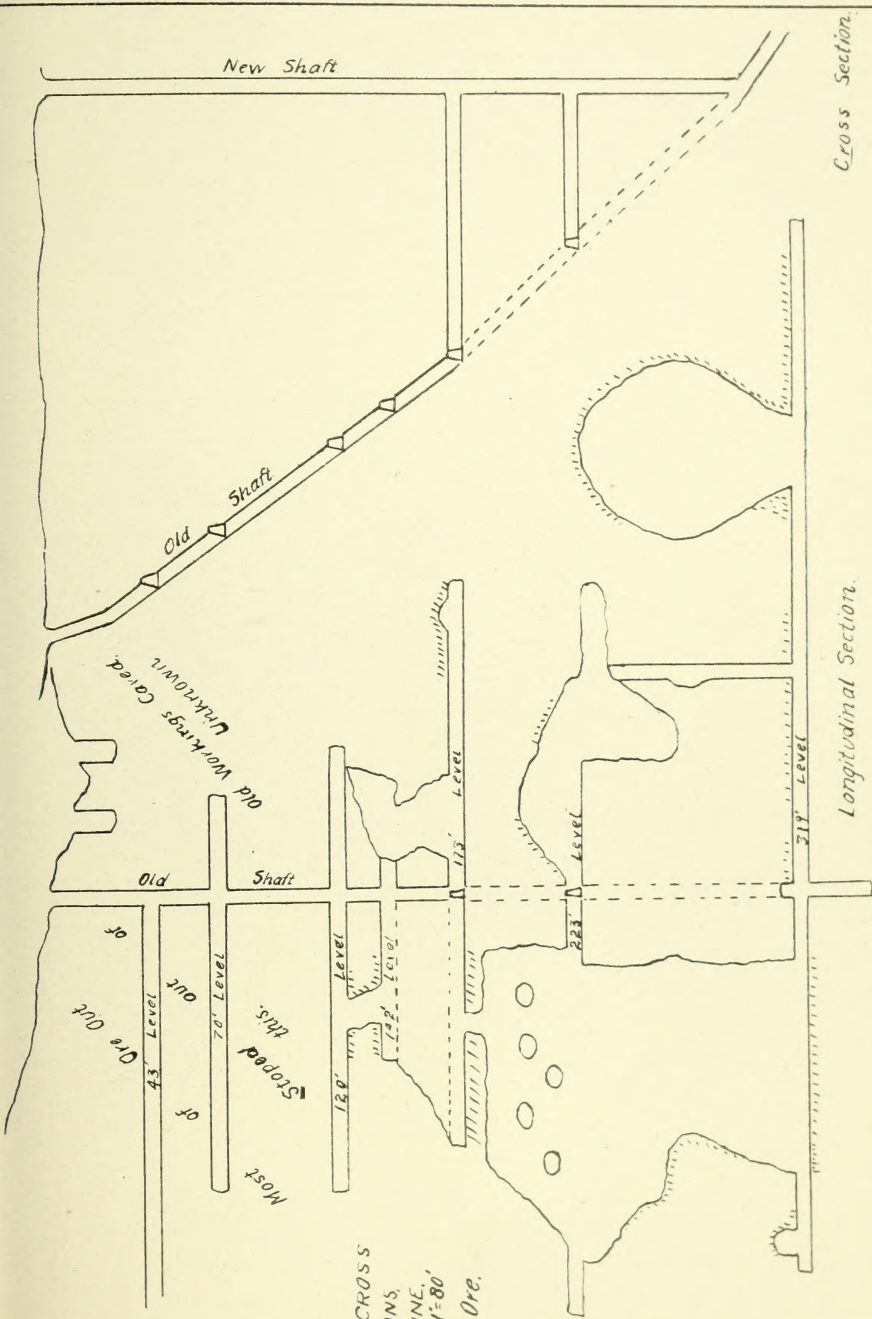
The mine was opened by an inclined shaft 6 by 10 feet in the clear to the 173-foot level. On account of its great size, it was then lost by its caving near the surface. It is now being worked by a shaft of the same size, vertical to the intersection of the vein at the 319-foot level, where it is turned on the incline, and was being sunk to open up a new level. Much of the ore was formerly removed by underhand stoping, without labor-saving appliances. Mr. Jones, the superintendent, has begun to work it more systematically, and expects to mine the \$10 and \$12 ore left in the upper parts. The ore is hoisted in a small bucket (holding about 1,000 pounds) and transferred to a 20-stamp mill by a Hunt automatic railway. The ore is so soft that there is no trouble in milling it and saving about three-fourths of its value by plate amalgamation. The tailings are elevated and sluiced to the cyanide mill, described on page 29. There are no harmful substances in the ore whatever, since the vein seems to be thoroughly oxidized as low down as could be examined. In places 2 feet or more of the slate on each side of the vein is also decomposed and stained red.

MONTGOMERY MINE.

The Montgomery Mine adjoins the Iola on the north. The 50-foot level from the old shaft has a drift south into the Iola ground, where it is said to show good values. It was inaccessible at the time of the visit. The 150 and 235 foot workings are shown on the accompanying sketch map (Pl. XVIII). This shows that there are at least two distinct veins, although they are not very continuous and seem to be faulted in one place. On the 150-foot level the foot-wall vein near the shaft yielded considerable ore in the raise, reaching the 100-foot level, where it connects with the drift nearest the shaft. About half-way up, there is a subdrift with considerable stoping. The position of the small amount of quartz that could be seen is shown on the map by the dots nearest the old shaft. On the 100-foot level this drift extends 150 feet north, or 100 feet beyond this winze. South of the shaft it follows the vein all the way into the Iola ground, and

is said to have yielded the best ore in the mine, and in the Iola ground to show 3 feet to 18 inches of \$30 ore. At the 100-foot level there is also the cross-cut 150 feet to the west, where it cuts the small stringer corresponding to the hanging-wall vein on the other levels. On these stringers there are drifts about 100 feet long. There is also a barren cross-cut 50 feet long to the east from the shaft. These workings were full of mud and not visited. The main cross-cut to the west on the 150-foot level seems to follow the fault plane. Where this cross-cut first cuts the hanging-wall vein a short drift to the south shows coarsely honeycombed quartz; where it strikes the other part of the vein it turns N. 62° E. for 60 feet, showing good ore all the way from 12 to 18 inches wide and dipping about 45° N. W. The 235-foot level is the only one open from the new shaft. This shaft is 6 x 10 feet in the clear. The hoist-way, 6 x 4 feet in the clear, is equipped with a fine cage for hoisting mine cars directly to the surface, with no rehandling. The ladder and pump-way is 6 x $5\frac{1}{2}$ feet in the clear. On one end it contains a 4-inch water column and steam and exhaust pipes for a large Cameron sinking-pump, as well as a $3\frac{1}{2}$ -inch compressed air line. On the other end are platforms or collars, each 12 feet, with nicely inclined ladders 16 feet long, reaching from one well above the other, so as to make a very convenient ladder-way. The shaft is timbered with 12 x 12 oak sets, 4 feet center to center, with 6 x 14-inch dividers and 12 x 12-inch posts; 2 x 10-inch oak plank 8 feet long, spiked to the sets in 16 lines breaking joints, serve as hangers and guides for putting in the sets. Each 14 to 20 sets is fitted with a 12 x 12 end-bearing piece notched into the solid rock to carry the timbers above it.

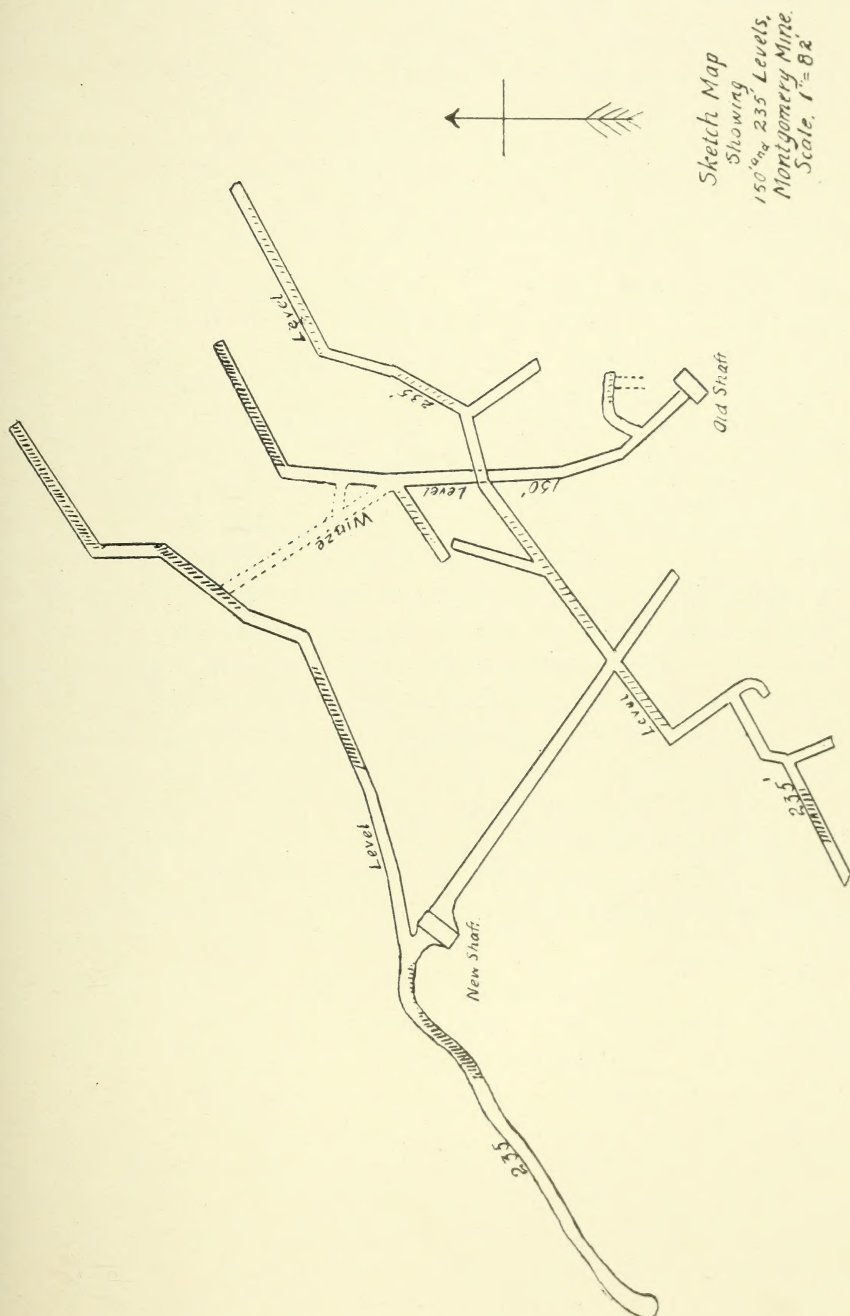
The new shaft cuts the hanging-wall vein a short distance above the bottom, and after a short cross-cut the main drifts were driven along it, as shown on the map (Pl. XVIII), 200 feet to the southwest and 300 feet to the northeast. Except the last 20 feet, the southwest drift follows the vein all the way. This is good-looking quartz, but very narrow. From 20 to 50 feet the vein turns more nearly south and is stoped for a length of 25 feet, to a height of 20 feet. There are nearly 3 feet of good-looking quartz, but it is separated by a good deal of country rock between the stringers of quartz. To the north there is also a little quartz all the way to the fault beyond the winze. Where the first cross-hatching is shown on the map is a nice little streak of ore 6 to 15 inches wide. There is also a little ore, appa-



LONGITUDINAL & CROSS
SECTIONS
IOLA MINE.
Scale, 1"=80'
Lullum Ore.

Cross Section.

Longitudinal Section.



rently of lower grade, near the bottom of the winze to the 150-foot level. There is said to be ore all the way up this winze, which connects with the small amount of ore shown on the 150-foot level. A little way beyond the winze the ore is thrown 27 feet almost due north by an apparent fault dipping 75° to the west. The last 63 feet is again along the usual course of the vein, N. 56° E., and shows from 18 to 30 inches of white, sugary quartz, resembling the best ore in the Iola, and said to be worth \$30 per ton. The mine makes a good deal of water, and at the time of the visit to the camp the lower level could only be entered for about an hour and a half after it was pumped dry at noon.

From the bottom of the new shaft is a drift southeast 135 feet long. At 46 feet from the end are the irregular drifts and cross-cuts shown. Right at the cross-cut it contained a few grains of coarse crystallized gold. The last body to the south has been stoped slightly and resembles the hard, glassy quartz of the Iola Mine, which contains some gold next to included bits of yellow altered slate.

On the Montgomery ground is another shaft, about 250 feet west of the main shaft, which was boarded up at the time of the visit, but shows a large dump of nothing but white, milky quartz, said to be of no value. There are other veins known, but no work has been done upon them. There is at present good ore in the northeast end of both the 150 and 235 foot levels, which may prove a rather continuous body upon further exploration. The mine is equipped with a stamp mill and a plant for cyaniding the tailings sand, which is shown in Plate VIII. The fine tailings, or slime, are not cyanided. They have a good shaft-house and hoist and air compressor, and seem to be very well equipped.

GOLCONDA MINE.

Next, north of the Montgomery Mine, is the Golconda, owned chiefly by O. M. Allen, Jr., of 65 Cumberland Building, Washington. At the time of the visit the Carolina Mining Company had just lost its option by failure of payment, after tearing up the main large vertical shaft and trestle to the mill and starting a three compartment incline, which was down only 70 feet. The mine was full of water at the time of the visit and inaccessible. The incline is 4 x 13 feet in the clear, the ladder-way being 2 feet 10 inches wide and the hoist-ways 4 feet 9 inches, fitted with steel T rails, etc. The mine is now

in charge of Mr. John J. Bloom at Candor, who gave me information as to lower workings.

In the vertical shaft 50 feet down are drifts 50 feet northeast and 50 feet southwest and 90-foot drifts about 75 feet long each way. There is a 10-foot sump. These workings are said to show a 4-foot vein of ore worth from \$4 to \$100 a ton (probably nearer \$4). It gave from \$4 to \$40 by free milling, averaging about \$20. The last 30½ tons milled yielded 15.1 ounce gold with tailings worth about \$5 a ton, indicating a value of about \$15 per ton. The slates on the foot-wall side seem to be mineralized for some distance, said to be for 50 feet. At 4 feet away from the vein a single assay gave a value of \$2 per ton and pyrites show nearly to the surface in these slates.

What is believed to be the same vein shows in another shaft across the creek about 250 feet N. 40° E. from the main shaft. A good deal of the dump has been hauled away, but what is left shows a good, red honeycombed quartz. At 50 feet down there are some folds and irregularities. About 150 feet northeast of this shaft the vein is cut off by a diabase dike, but it can be traced to the southwest past the Montgomery Company's property. The Golconda Company owns 150 acres of land containing about ½ mile of the strike of the vein.

There is another 50-foot shaft on a narrow but supposedly richer vein 140 feet east of the main shaft, and it is possible that the slates contain more or less pyrites between the two, but no good exposures could be found. There are two other 50-foot shafts on supposed 4-foot veins west of the most developed vein, but they were somewhat caved and the dump seemed to be mixed with slate, etc., and they do not look so good as the other veins.

The company has a fine little stamp-mill in good condition, a small saw mill, a comfortable office and dwelling. Mr. Bloom thought the original company would begin work again as soon as it had the Carolina Company straightened out. Although the vein is probably not as regular and continuous as represented, the mine certainly looks like a very good prospect.

CARTER MINE.

This is owned by Sam Smitherman and others of Troy, N. C. It will be worked by Mr. W. T. Sawyer, now of Biscoe, N. C., formerly of Lincoln, Neb. It is an old mine that has produced a good deal of high grade ore. Two shafts were sunk a couple of years ago by Smitherman and associates. From Mr. Sawyer's account it seems to be on a contact of gneiss and trap which is full of small stringers of quartz and has recently been faulted so that there is a rather large chimney of soft material. Mr. Sam Smitherman and Mr. Charles Armstrong, of Troy, state that most of the old gold was taken from the 65-foot level, from a nearly horizontal seam, which was stoped in an approximate circle 200 feet in diameter. There was also some working at 110 or 120 feet. Mr. Smitherman and his associates attempted to reach these old workings but got discouraged by heavy ground, etc., at 75 or 80 feet, although they did succeed in running a drift to the main stope on the 65-foot level. In one of the shafts, part of the way, they followed a seam from 0 to 4 or 6 inches wide, assaying \$400 or \$500 a ton. In drifting to the old workings they cut one streak from $\frac{1}{2}$ inch to 6 inches wide, assaying \$1,700 per ton.

TROY MINE.

This mine is 7 miles northwest of Troy, Montgomery County, and in July, 1906, a company of northern men, under the direction of Mr. E. T. Gould, of Reading, Penn., began to operate it. The principal open cut, No. 2, is about 500 feet long, 2 to 10 feet deep and shows an ore-bearing zone 20 to 24 feet wide. It was made by recent hydraulicking with pumped water, but only a small amount of gold could be saved. The ore is a band of soft, thoroughly decomposed slates, either very fine sand, or, in other places, plastic clay. It shows some limonite cubes often an inch on the side and rich in gold. On the northwest side of this cut there is exposed a vein of hard, milky white, partially crystallized quartz.

Across the creek in the same line as open cut No. 2 is the old Moore shaft, an old caved hole showing a narrow seam of more firm and siliceous slates. There are some trenches in the other direction from open cut No. 2, which show the ore-bearing zone to continue nearly to the property line and possibly beyond, this having been determined by panning tests. There is no visible difference between

the ore-bearing zone and the thoroughly decomposed rock on either side of it. There is another vein, exposed in a small hole 300 feet northwest of open cut No. 2, which is supposed to extend across the small branch to a deep shaft beyond, and following a more or less continuous line of white, milky quartz fragments to open cut No. 1. At the old shaft this is a rather firm siliceous, sericite slate, containing abundant limonite cubes. At open cut No. 1 it is a little harder and looks like a dike of badly decomposed porphyry with slaty cleavage. In the center of open cut No. 1 the ore was quite rich and a shaft sunk there produced a good deal of \$30 ore; this cut is not very large, but seems to show the upper part of a rounded ore body some 15 to 20 feet wide and, as far as opened, 60 to 70 feet long. At one end it seems to have turned off into the porphyry. It is full of brownish, yellow streaks in whiter, pinkish clay, and these streaks pan very well. To develop it deeper a new shaft has been sunk in the hanging walls a short distance away. This was just cutting into hard pyritic sericite, at a depth of 70 feet, when it was stopped. There is a good little steam hoist with boiler, etc., and the shaft is not unnecessarily large. On the hilltop northwest of open cut No. 1 is a long trench which is estimated to carry from \$0.75 to \$1 a ton by pan tests, though no definite vein has yet been found. Still further northwest is another vein which outcrops about due west of open cut No. 1, but is there barren. Further southwest this vein crosses a little branch which has produced much coarse and nuggety placer gold. There is an 18-foot shaft on this vein near the bed of the creek, at which point the placer gold ceased. This shows sulphides practically to the top, with some quartz, some sericite and some black slates. It is supposed to be worth some \$5 to \$6 per ton.

The first attempt at working the property was the hydraulicking of open cut No. 2 after a little exploratory work in open cut No. 1. It seems that this was not expected to pay, but merely used to uncover the vein, an extremely expensive method, however. Then the 70-foot shaft at open cut No. 1 was equipped and abandoned as soon as the M. P. & C. machine attracted attention. One double unit of these machines was installed at the small creek just below open cut No. 1. Water was pumped from the original placer pond and pumping station to a tank at the shaft house and used to sluice the ore through a trench from open cut No. 1 to the mill. The machines were not very intelligently managed and most of the gold from open

cut No. 1 is said to have run off in the tailings. At the time the property was visited they were hauling 100 tons over fearfully muddy roads from open cut No. 2 for testing, and were talking about installing an aerial tramway. Mr. Gould reports that they also failed to save the gold in this ore, although it panned very well. They are now installing a 50-ton experimental cyanide plant since they have struck some fine ore in the bottom of an 18-foot shaft near the side of open cut No. 2.

RUSSELL MINE.

This mine is owned by the Whitney Company under the name of the Yadkin Consolidated Mining Company. It is described in detail in Bulletin No. 3, page 74, and no work has been done since then. It is possible that the so-called veins or leads are pretty nearly isolated lenses in the slates, something like those at the Haile Gold Mine, South Carolina. If anything, the ore-bearing zone could be said to run across the slates, for the bodies worked are in a straight line, although conforming more or less to the trend of the slates.

The Little lead dips at nearly 45° and has been extensively stoped for some 200 feet to an unknown depth and 3 or 4 feet wide. In continuation of the big cut there seems to be another large body of the silicified slates, possibly carrying values in other parts, but which are said to pan very little where exposed. There is some ore remaining in the end of the big cut, but at the shaft end the slates were quite barren until a depth of about 210 feet was reached, where they carried a good deal of pyrites and are said to have some value, although except for the pyrites they look just like the country slate. A great deal of work has been done on the Riggins Hill lead and there are extensive open cuts and caved stopes. To the north this seems to end abruptly. The Soliague lead seems to cross the Riggins Hill at a slight angle just before it crosses the little branch. On the other side of this branch there are some other workings apparently in continuation of the Soliague lead. The open cut shows a clear cross-section of a wide band of silicified slates.

PARKER MINE.

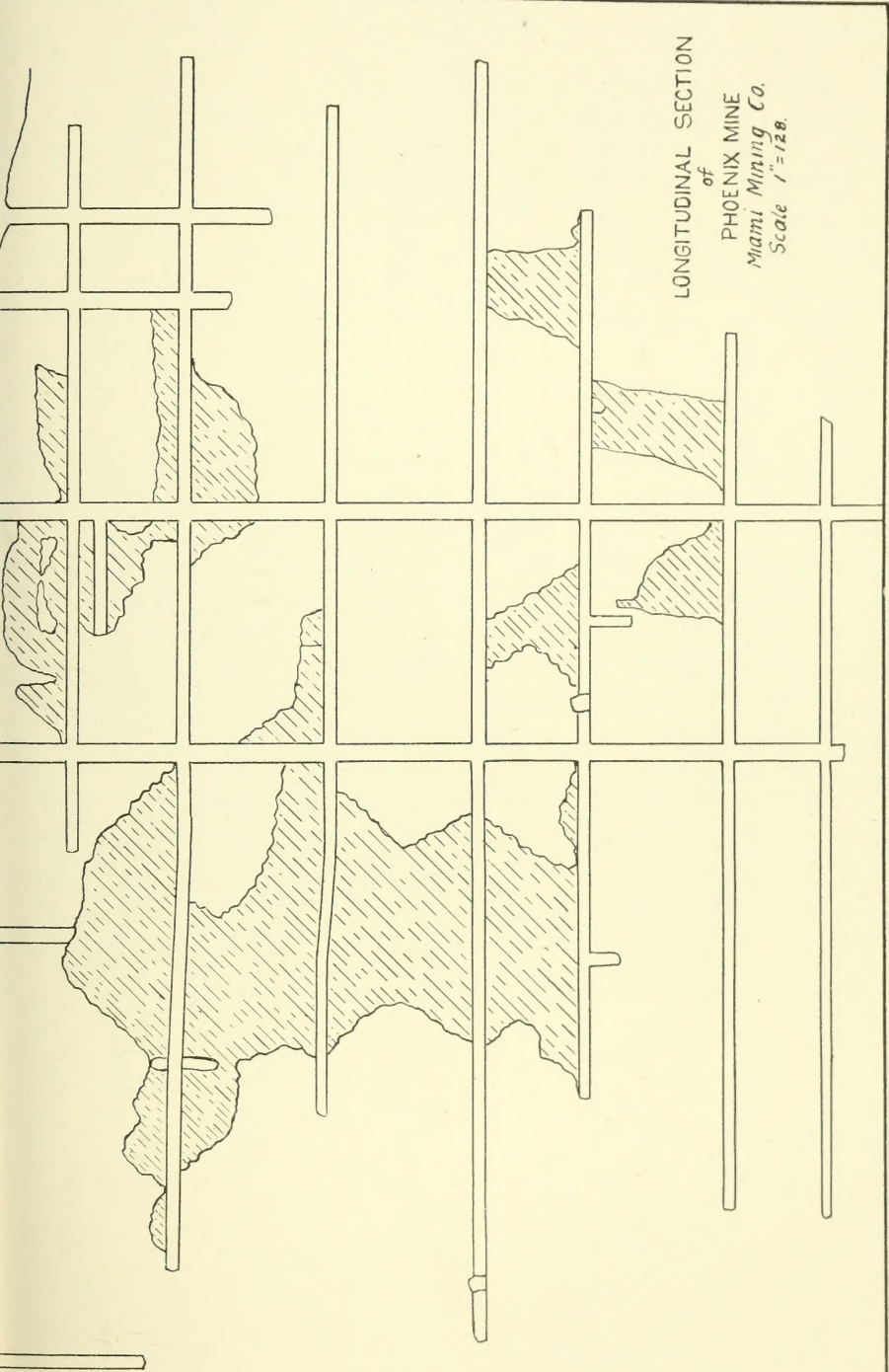
This mine is near New London, Stanly County, and has long been idle. It seems to consist of an area of a decomposed basic porphyry, probably diabase. In this mass is an indefinite network of quartz

veinlets, usually from $\frac{1}{4}$ to 6 inches thick, and occasionally forming good sized masses at intersections, and so forth. The auriferous area is about one mile long and 600 to 700 feet wide. The rock is said to be pretty soft to a depth of about 80 feet. There is a theory that the stringers will unite with a so-called mother vein in the district. This was pretty rich at one place and was up to 3 feet wide. A shaft was sunk 115 feet on it, giving a hade of 15 feet in a hundred. In this shaft the vein is 14 to 16 feet thick in places and is reported to assay up to \$160 per ton; at other places the vein is a mere stringer. In the second gulch from the railroad track is a quartz ledge composed of many stringers close together up to 12 feet wide.

The mine was opened by an English company using the Dahlonga method. They sluiced a ditch 30 feet deep for half a mile to the center of the deposit. This did not pay until the network of veins was reached during the last month. Work was abandoned the next month as a result of orders from England. At intervals the negroes do a little washing for placer gold above the saprolites, paying 25 per cent. royalty. There are parts of this deposit which could probably be worked at a profit by the M. P. & C. machines. The deposit differs from the Shuford Mine in that the veinlets are wider and consist of more solid milky quartz, generally fractured, but not honeycombed or iron stained.

THOMPSON MINE.

Dr. V. A. Whitley owns the old Thompson Mine, 5 miles east of Albemarle, Stanly County, and one mile beyond the old Ingram. This has recently been optioned to parties who expect to work it at once. There is one shaft 15 feet deep, one open cut 30 to 40 feet wide, 100 feet long and 25 feet deep. At a depth of 20 feet in this is a tunnel 55 to 60 feet long to the northwest; also irregular cross-cut tunnels to the porphyry dike on southeast. Cuts and stripping near the shaft show a zone of slate a little harder than the country rock with disseminated metallic mineral, often thickest along the laminae. In the cuts the ore is oxidized and pans a little free gold. The strike of the slates varies, but seems to average N. 40° E. magnetic with a dip of 54° N. W. and they seem to carry slight values. During the sinking of the shaft a wagon-load sample was taken and found to assay \$4.25; at a depth of 16 feet it gave \$4.40 and at 22 feet \$6.40. The pyritous ore in the gulch runs about \$2 a ton. The ore



from the cut was milled in an old 10-stamp mill at a profit, but there was trouble with clay from the decomposed earthy slates, so that but little of the gold was saved from this ore, and work was stopped.

This mine offers a favorable opportunity for using the M. P. & C. machines, for the rock is just like that at the Empire Mine. The unaltered slates, however, are too near the surface to give much of a tonnage before they become hard. There is a wide diabase dike across the country on the southeast side, but this carries no value, and prospecting on the far side of it shows no ore.

PHOENIX MINE.

The Phoenix Mine was closed down in July, 1906, and at the time it was visited was in charge of a millman, Mr. Morris, who had two men firing a boiler used in running an electric pump. The mine was profitably worked by Mr. A. Thies and is based upon a somewhat branching white quartz vein in the middle of a wide diabase dike. The vein is from a little stringer to 3 feet thick. The workings are shown on the accompanying map, Pl. XIX. The last two levels were opened up by the Miami Mining Company, which also sank the pump shaft from 225 feet to the bottom. There is an excellent description of the vein, with map of Mr. Thies' work, in Bulletin No. 3, page 121. The new company has stoped some smaller shoots to the west of the main shoot and on the lowest level have apparently found a good continuation of Mr. Thies' shoot of gold ore, which is over 2 feet thick. The old shoot had pinched to nearly nothing on the next to the lowest level.

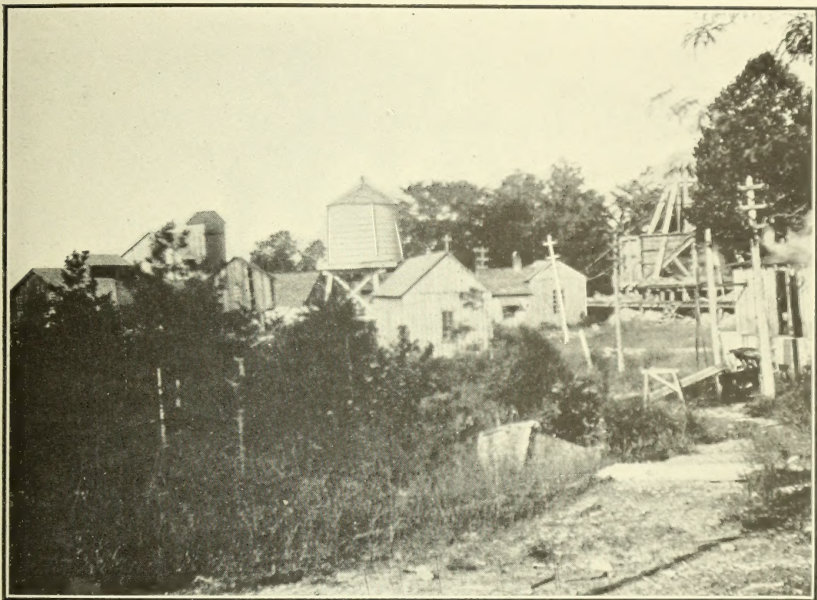
The ore cannot be worked profitably in a cyanide plant on account of the 2 per cent. copper present. The mine is very well equipped, with one 150 horse-power Sterling water tube boiler; one 75-K. W. generator and one 30-K. W. generator; one Sullivan straight line air compressor with cylinders 9 x 12 and 9 x 16 inch, capacity 500 cubic feet free air per minute to 110 pounds per square inch, at which pressure the cylinders are unloaded; electric pumps; and a complete machine-shop with planer, lathe, drill press, etc. The ore is first passed over a picking machine, from which it is dumped into a Tullock feeder and to a revolving trommel; inside of the trommel is a spray pipe to wash the ore and two different sizes of product are picked off and thrown into a bin for tramping to the dump. The

fine earth, etc., washed off is raised by a pump directly into the mortars of the stamp-mill. They have 10 stamps, each weighing 1,100 pounds, and said to be the heaviest in the State. This is followed by three Bartlett tables and one Gammet table. The large percentage of concentrates is treated in a 3-ton chlorination mill, with one barrel and one new roasting furnace. About 57 per cent. of the assay value of the ore is saved by amalgamation and the total saving is 87 per cent. Chlorination costs about \$7 per ton concentrates. The mill ran four months only and the chlorination plant two months. See Pl. XX, A.

There are reports that the Allen-Boger property, near the Phoenix, will be developed. Small pits show a vein from 1,500 to 2,000 feet long and as far as can be seen from the old workings 12 to 15 inches wide. There is some ore at the top, consisting of quartz, with a good deal of pyrites, which is worth about \$40 per ton. At this shaft the granitic walls are 2½ feet apart, but there is a good deal of slate filling and the quartz is only 3 to 12 inches thick. The deepest shaft is about 40 feet and dips 75°.

INDIAN TRAIL MINES.

At Indian Trail, Union County, Mr. J. L. Yont was in July, 1906, making tests in a 5-foot Huntington mill with copper plate on old dumps for the old Phifer Mine or Price tract. These tracts are as described in Bulletin 3, page 100. The old Davis tract of 400 acres has recently been purchased by a company with R. L. Welch, of Thomasville, President, for \$20,000. They will work the old dumps and soft rock between the old rich shoots in the M. P. & C. machines. The old works are on a pretty continuous zone for 900 feet on the Davis Hill and between 300 and 400 feet on Moore Hill. These old workings seem to be very irregular and not on parallel seams as described. The rock is decidedly soft to a depth of 30 feet and there should be no especial difficulty with the machines. The old dumps have been cut through and sampled. These are said to show \$2.60 to (in one case) \$27 per ton, averaging probably \$3, which checks up the old report. A 60-foot ditch across the Moore Hill Mine gave an average value to the top of the bed-rock of \$10. The amalgamation tests were being made for another concern and it is likely that all the old tracts will be taken up if the first is successfully worked.



A. GENERAL VIEW OF MILL AND CHLORINATION PLANT OF THE PHOENIX MINE.



B. OLD-STYLE LOG WASHER.

Water will be pumped from a small creek some distance away and reused.

The Price tract includes the famous Mint Hill pit. It is said that a flat seam of barren quartz cut off the ore at Mint Hill. Most of the old workings were caved and inaccessible.

Mr. Yont was superintendent of the Black Mine, at Indian Trail Station, which was recently closed. The 10-stamp mill, etc., is still there. The main vein strikes N. 20° E. and dips slightly east. This is said to have been 9 feet wide at the widest place down to 2½ feet, average 4½ to 5 feet, worth \$5 to \$12 per ton in free gold, average about \$8 to \$10 per ton, with one ton in twelve concentrates worth \$40 to \$60 per ton, chiefly galena, chalcopyrite and pyrite with a little sphalerite and bornite. The few tests on the tailings showed \$3 per ton. The vein is described as quartz mixed with slate and bunchy and not well defined, and it was almost certainly carefully hand-picked before milling. The 10-stamp mill treated 12 to 15 tons in ten hours. The sulphides began at a depth of 30 feet and the ore in the breast of the main drift in the lowest level (150 feet) was still good.

Thirty feet south of the main shaft is a cross-stringer of richer ore about 3 feet wide, which was followed with drifts for 50 feet to the east until it pinched out.

The main shaft is 170 feet deep; at 40 feet is a drift 60 feet to the north and 30 feet to the south, with some stoping to the south near the intersection on the small vein. At 100 feet is a drift 85 feet to the south with a stope for the first 75 feet connecting with the shorter one above. At 150 feet is a short cross-cut to vein and a drift 100 feet to the north. For the first 60 feet the ore was low grade and a triangular block 40 feet high at the shaft was left; all the rest was stoped to the 60-foot drift on the 40-foot level. There is a 30-foot winze in the lowest level where the good ore was first found, which shows an 18-inch streak of solid sulphides.

The old Smart Mine, one mile north of Indian Trail, has been reopened as the Bonnie Doone Mine by J. C. Bates, former owner of the Howie Mine. It has recently been closed down on account of Mr. Bates' poor health. Information was given by Mr. R. S. Irby, since the mine was full of water and not accessible. He cleaned out one of the old 80-foot shafts and found a good ore shoot, and therefore sunk the shaft to 200 feet. At 60 feet is a drift to an old 51-foot shaft 95

feet southwest and a stope to the surface. There is also a 126-foot drift south. At 120 feet is a 100-foot drift southwest; at 186 feet is a drift 90 feet southwest and 70 feet northeast. There is no stoping from new work. On the surface is a large dump which has been thoroughly trench-sampled by Gaiford and Dinnwiddie, mining engineers, who report 3,000 tons of \$15 ore. This dump is a very siliceous sericite schist, with stringers of more micaceous and argillaceous slate, and seams and bunches of white quartz up to a foot or more across. There is a separate smaller dump, consisting chiefly of slate, with seams of white quartz, say 500 tons, which is said to have come from the shaft which misses the slightly inclined vein by 4 feet at the bottom. This part of the vein is said to strike N. 60° E., and is nearly vertical. It is said to be wide and without definite walls, and that the slates on the sides are worth something like \$2 per ton. There is one cross-cut showing a 15-foot vein. There is one rich shoot west of the shaft, cut on all the levels and stoped above the 80-foot level. At the bottom it is about 35 feet long and 7 feet wide at the middle, and worth \$12 per ton.

The new workings are generally reported to have shown up well, and the size of the dumps corresponds with the statement of work done. The shaft is only 7 x 10 feet and is fitted with a 15 horse-power bucket prospecting hoist. There is a good deal of water, and the sinking-pump is handled by a capstan at the surface.

There are old pits for 250 feet southwest of the new shaft, and at 650 feet northeast is the old "engine shaft," with a few pits between, and extensive work on beyond for 800 feet. The old shaft is rumored to be 130 feet deep. A few years ago it was cleaned out to a depth of 50 feet, and the ore in an old drift to the west 15 or 20 feet long was found to assay about \$10 to \$12 per ton. The old dumps are refractory and rather low grade, a few samples showing \$3 or \$4 per ton. Sixteen hundred feet south is the parallel "lead vein." There is one old shaft 125(?) feet deep, but not recently worked. At the engine shaft is a little slag from smelting of lead-vein ores.

MOORE MINE.

About 6 miles north of Indian Trail, Union County, is the Moore Mine, now being worked by the Moore Mining Company, under Mr. R. J. Wentz. They did some work on the No. 1 vein, which is the one described in Bulletin No. 3, page 95. They sank a new 5 x 7-

foot shaft 80 feet and found a few more little bunches of the soft, white calcite 5 to 6 inches wide and "held together by wire gold." There were observed pieces of the trap "greenstone" wall, with large splashes of sheet gold. At the bottom of the shaft a 15-foot cross-cut into the trap-hanging wall shows irregular, crooked stringers of white quartz, with much sphalerite and less galena, chalcopyrite and pyrite. This assays about \$4 or \$5 per ton, and there is more at the end of the cross-cut. The vein strikes N. 10° E. and dips about 80° E. At 1,200 feet south is an old open cut, showing the sulphides in trap. There are some small pits between, and at about 1,200 feet still farther away is a 65-foot shaft showing the same. At neither place is there a cross-cut.

The recent work is on No. 2 vein, one-half mile east of the Batchy shaft on No. 1 vein. The main shaft has recently been sunk 180 feet. At 90 feet is a drift 100 feet southwest and to the old property line 50 feet northeast. All these workings are said to show a vein with sharp walls 3 to 8 feet wide, averaging about 4½ feet and continuing to the ends of the drifts. No stoping has been done. The dump is nearly all white, milky quartz, with an included green altered remnant of replaced slate and a very little chalcopyrite. In one place is a little slate which is said to have fallen from the wall. A wide cut has been taken from the center of this dump and milled in a little 3-stamp mill, and is said to have yielded \$4 per ton on the plates, besides the very small quantity of rich concentrates. This vein strikes N. 75° E., or at a high angle with the one in the dike. No. 3 vein is parallel to No. 2, about 150 feet away. On it are two shafts, each 50 feet deep, with about 50 feet of drifting at each. These show a 4-foot vein of white quartz, which is thought to be a little richer than No. 2. There is a wide zone of loose, white quartz along the outcrop for a long distance.

The main shaft has a small boiler and hoist. The little mill with three stamps, weighing 350 pounds each, cost \$700. The company has just bought the adjoining land, into which the veins extend, for tailing room, and has ordered a 10-stamp mill, 30 horse-power hoist and 40 horse-power boiler.

COLOSSUS MINE.

An English corporation, called the Colossus Mining Company, bought the old Howie Mine, Union County, and expected to cyanide the entire ore-bearing zone, as described on page 28.

Mr. Neilsen, the mining engineer, claims that the zone is in a compressed incline from the outcrop of a stratum of quartzite. When he gets into some of the contacts the veins will supposedly get richer. From Mr. Neilsen and the foreman, and from observation, it was learned that there is a number of veins in the zone, and in the veins little ore shoots pitching about 70° E. in the nearly vertical veins. The rock is all a very hard, black silicified slate. In the veins it is partly replaced by lighter grey quartz in seams, and still showing the bedding. Mr. Bates mined chiefly the Bullface and Netty veins. The Netty was quite a large shoot opened by three or four small shafts and left in pretty bad condition. In the bottom of the stope is a winze sunk on a 14 x 14-foot rich shoot.

The Bullface is in section a horse-shoe which has been opened by a vertical shaft 107 feet and a very crooked incline 141 feet from the bottom. In the toe and bottom of the horse-shoe was the rich streak 6 feet thick and about 14 feet long. Samples at vertical intervals of $21\frac{1}{2}$ feet gave the last 40 feet an average value of \$61.50 per ton. Stringers of low-grade ore join the heels of the horse-shoe, and at 40 feet from the bottom considerable stoping was done on one of these, called the Egypt vein, which strikes N. 55° E. There was about 12 feet of \$5 ore within the horse-shoe which was removed for the skip-way. The possible average dip of the horse-shoe is between 70° and 80° . Below the Egypt vein level the rich shoot is 7 x 14 feet.

The company is now sinking an 8 x 18-foot shaft, with two hoist-ways 5 x 6 feet in the clear, and ladder-way to intersect the Bullface vein somewhat below the 500-foot level. This shaft is timbered with 10 x 10-inch oak sets, 6 feet center to center, although the rock is so solid it requires no support. After sinking 12 feet a hitch is cut to support the set, and two sets built in from this bottom. Since they cannot be drawn up by hangers, as usual, the posts (locally knees) are supported by 2-inch plank nailed to the sets. The framing is the complicated bevelled mortice. A "false set" is built in below the last permanent set, used also to protect and support the No. 5 Cameron sinking-pump. The shaft is sunk with one eight-hour shift of six drillers and foreman, working three machines. The next shift pulls the machines, blasts the holes and mucks. The third shift finishes mucking. When things go well they make 12 feet per week, but the average is only 30 feet per month.

Above the shaft is a splendid head-frame with double drum-hoist, etc. An ordinary small hoist, such as would be commonly used for sinking, is used here to raise and lower the suction pipe of the pump. The carpenters were at work putting up an enormously heavy frame to support the water-tank at a height of some 35 feet. Besides the cyanide mill, etc., there is a 3-drill and 16-drill air compressor.

The big shaft is now 230 feet, and will be driven to 560 feet, when a little drift will be driven along the vein to the Bullface. It is sunk in a more silicified zone or vein about 8 feet thick. In sinking, three ore shoots were cut, dipping, as at the Bullface. The largest one is about 5 feet wide and runs \$45 to \$47. The others are only 2 to 2½ feet wide, and run \$24, \$29 and \$9.60 as an average of all the samples taken while they were cutting diagonally across the shaft. At the 150-foot level are drifts 25 and 50 feet. Samples were taken in these, 8 feet in the west drift and 3½ feet in the east drift, which include only the best or most siliceous ore exposed. There is also a cross-cut 140 feet to the north. At 115 feet they cut a 4-foot vein of \$4.54, believed to be the one that contains the Netty shoot. There are also other small seams. The cross-cut, 130 feet to the south, shows nothing. These cross-cuts will be driven to the limits of the hard, silicified zone. There are various dark-green dikes cutting square across the country, and the general body of the veins is richer near them. These veins are merely zones with more light-colored quartz.

At 265 feet a drift will be driven to unwater the old Bullface workings, and it is not anticipated that there will be much water in the lower levels. At 560 feet they expect to strike the "contact" and get into less disturbed country, in which there will be more nearly continuous ore bodies. At this level they will stop sinking and drift.

The ore is very hard, and the gold occurs as very thin flakes, parallel to the bedding, although the quartz does not split along the gold sheets readily as elsewhere, so the fresh ore cannot be cyanided. The laminations of the ore are said to have followed the curve of the Bullface horse-shoe.

The Union Mining and Development Company is developing a placer prospect seven miles south of Monroe. It has 40 acres, with gravel 3 to 4 feet thick, under 6 to 12 inches of soil. The ground covers an old valley with one branch. It will either pump water and hydraulic or install the M. P. and C. machine. J. H. Beckly, of Monroe, is general manager.

WILHELMINA MINE.

This mine is 5 miles west of Charlotte, Mecklenburg County. Messrs. C. A. Ames, W. D. Rock and associates put up a little money, and, under the direction of Mr. Ames, cleaned out the old shaft 75 feet deep, cross-cut to the vein, drifted 200 feet along it, and stopped. Then Mr. Rock insisted upon sinking a new vertical shaft, which cut the vein at 90 or 100 feet in a low-grade spot. They did no drifting, but started an upraise along the 45° vein and began to stope as soon as the ore got good, since they had already put in a 10-stamp mill to work the little dump that Mr. Ames had accumulated. On the 75-foot level the vein was $2\frac{1}{2}$ to 3 feet and averaged \$5 to \$6 on the plates. The concentrates were not sold, except a trial shipment to the Atlanta smelter, and this netted a little profit. They took out from \$10,000 to \$12,000 in eighteen months. The vein will probably average a little less than 45° dip, with a strike 15° E. of N. There was a larger amount of sulphides at the bottom, but it was still somewhat oxidized. They owned only 15 acres.

SUMMERVILLE MINE.

This is on a 10-acre tract 6 miles west of Charlotte. Another small group of men put up a little money to develop this, and Mr. Ames sank a 50-foot shaft along the nearly vertical vein, 85 feet from an old 50-foot shaft. The drift the full width of the vein, about 10 feet, was driven from shaft to shaft, when their funds gave out. The vein shows for several hundred feet on the surface and is about 8 feet wide, in granite. The solid sulphides assayed \$64 per ton. It was sampled by a Colorado engineer, who thought well of it. The results of his sampling are not known, but Mr. Ames has great faith in the property.

RUDISIL AND ST. CATHERINE MINES.

A company has recently bought these mines, in Mecklenburg County, and will put up a mill near the St. Catherine shaft to treat 50 tons in twenty-four hours, consisting of crusher, Monadnock mill, two shaking amalgamating plates, Trent hydraulic cone classifiers and eight Wilfley tables. They will crush somewhere between 30 and 150 mesh, as practical tests show best. It expects to cyanide the tailings, since the ore contains very little copper. It will ship the concentrates, if advantageous terms can be secured; otherwise it

will accumulate them until there is enough to justify a roasting plant for chlorination or cyanide. They were getting ready to begin work on the mill in August, 1906, since they had just finished reopening the mine under the able direction of George E. Price, a mining engineer of South African experience.

The Rudisil Mine is in a zone of so-called slate, which may be only black sheared trap in the granite. The granite on the foot-wall side is partly replaced by sericite and secondary quartz. There are some massive trap-dikes in both walls. Within this zone have been worked out some quite continuous veins up to 8 feet thick. The high-grade ore has been shipped, and some 10,000 tons of material, running from \$6 to \$9.50 left in the stope, which Mr. Price estimates to average \$8 per ton, after pretty careful sampling. There are also some 10,000 tons of \$5 to \$6 ore along the edges of the stope and in the pillars. On this tonnage Mr. Price will erect his mill. The shaft is about 200 feet vertical, and then about 150 feet on a 35° incline; but the lowest 50 feet were still full of water. The old levels resembled rabbit burrows, since the ore was either carried or wheeled out. The 250-foot level was being cut down for a car, and will be driven both ways. At 250 feet north of the shaft, just before striking an old winze from above, a fine bunch of ore was cut, and at the time of the visit, in the breast there was a seam of \$150 ore and 3 feet of quite low-grade ore. In the north drift, at 250 feet from the shaft, a cross-cut into the hanging wall encountered a very irregular bunch of rich ore. At the time of the visit the crew was tearing up a 2-foot horse of slate in the foot-wall of one of the stopes and mining 3 feet of good ore, containing high-grade streaks below it. There is a thinner seam in the roof, which will be stripped after the stulls and material are removed. The stope will then be packed with slate and the pillars will be removed. They have been shipping about twenty tons per month of hand-picked ore, averaging about \$125 per ton. They have equipped the shaft with a 2-ton self-dumping skip, described elsewhere. There is no certainty as to the dips and strikes of the ore streaks, and it is probable that more can be found at greater depth. At the time of the visit they were working twenty-four men, earning from \$1.10 to \$1.50 each, under the direction of an unusually intelligent negro foreman. They began pumping out the water in June, 1904, but put in the hoist and good pumps in Decem-

ber, 1905, since which time they have retimbered the shaft, built a very good shaft-house, etc.

The St. Catherine is the northern extension of the Rudisil. In it the slates are very much wider and the ore bodies much harder to find. Although the zone of slates dips to the west, some ore bodies dip to the east. They fork and branch in every way, but are mostly confined to the sides of the slate zone. At least three of the old ore bodies were quite extensive, and, with little sorting, yielded the very high-grade ore which made the mine famous. Mr. Price has found but two small bodies of shipping ore. On the 200-foot level he has extended the drift toward the Rudisil from 90 to 462 feet and is continuing it, and expects to cross-cut later. There is one lens of ore 75 to 80 feet long and 6 feet thick in the center, said to be worth about \$10. They are working this drift by contract, and, including the pump men and engineer, employ about ten men. The old Cornish pump has been repaired and is still working. The contractor gets \$9 a foot for the tunnel, including tramming, loading the bucket and dumping it at the top. The company does the hoisting and furnishes the tools. The mill will be built on the St. Catherine ground because there is no tailings room at the Rudisil.

YELLOW DOG MINE.

This mine is one mile south of Charlotte, on the southern end of the Rudisil-St. Catherine lead. A well drilled on the intervening country is said to have struck good ore, but no work has been done. On the Yellow Dog property there was one old caved-in shaft. It has recently been opened by Mr. Max Jasspon, who has sunk a 5 x 10-foot shaft 170 feet. At 160 feet is a cross-cut and a small, irregular drift. The vein is 4 feet wide in one place, but is seldom more than one or two feet. It is very flat and sometimes dips in a reverse direction. The vein is honeycombed quartz with included masses of sericite and silicified granite. There is coarse feldspathic granite on the hanging wall, and very black, somewhat micaceous slate on the foot-wall, which looks more like trap than that at the Rudisil Mine. At the time of the visit all of the available ore was stoped out and the ground was very wet and rotten. The main drift on the vein was 80 feet long to an 80-foot raise to the old shaft. The end of it has now caved in. The so-called cross-cut from the shaft has about the same direction, but shows no ore, and it is 17 feet long. There is now open one

flat raise, about 20 feet long, to a small stope-drift to the north, 15 feet long. This shows 2 feet of ore at the edge of an old raise. Ten feet further on, the raise becomes horizontal for 50 feet; at the angle of the raise the vein bulges to 2 feet 10 inches and then disappears. There is some badly mixed disturbed matter in the breast.

At the 170-foot level there is a cross-cut something over 60 feet long to cut the vein on the dip. It is all in rather soft granite, with some hard and some soft trap in dikes and irregular masses. It could not be told how thick the so-called black slate in the foot-wall of the vein is. The seams in the granite of the lower level are very nearly flat, and so some upraising may have to be done.

They have a fine 5-stamp mill, operated by an electric motor, and one Wilfley table. The concentrates, largely iron oxide and sulphide, to the extent of 15 tons, have not been shipped. The mill only ran a few weeks.

The Yellow Dog Company claims to have milled 300 to 350 tons in the 5-stamp mill (stamps 750 pounds each). The ore concentrated 1 in 3 to 1 in 20, but was very variable. The concentrates contain a great deal of iron oxide.

WOOLWORTH MINE.

The Woolworth Mine, one mile southwest of Charlotte, was closed down in July, 1901, because there was no mill, etc. It was under bond for \$15,000 till November 15, 1906. The mine was worked five or six months, and it is reported that \$30,000 was spent for mine and development. There is one shaft, 100 feet deep, with a drift 75 feet each way at the 70-foot level, and a drift 25 feet northeast and 20 feet northwest at the 100-foot level. There are two other shafts 65 feet deep, 300 and 400 feet from the deep shaft. There is some cross-cut work. This work shows a vein, like that in the Rudisil, from 2 to 20 feet wide. This dips 45° S. W., but strikes northwest and southeast instead of the usual way. They have mined some 3,000 tons and shipped one carload, which Professor Hanna found to be worth \$24 per ton. They own the property for 2,500 feet and claim \$20 ore.

Mr. F. L. Brown, mining engineer of Charlotte, worked a gold dredge on the Catawba River, near Charlotte, until it was washed away by a flood, but he expects to replace it soon. He stated that the sand is 20 feet deep, containing no interfering clay and much very

fine gold. He will put in a new kind of gold-saving plant to separate the gold from the black sand and monazite.

The Gray Mining Company is developing a prospect 8 miles southwest of Mocksville.

Near Ransom's Bridge, Halifax County, a dredge was operated a number of months during 1906.

PRODUCTION.

The total coining value of the production of gold and silver during 1906 was \$152,952, which is an increase of \$3,583, as compared with \$149,369, the value of the production of 1905. Of this 1906 production, \$122,008 was due to the value of gold produced, a decrease of \$7,145, as compared with \$129,153, the value of the 1905 production. The coining value of the silver produced was \$30,944, as compared with \$20,216, the value of the 1905 production, this being an increase of \$10,728. This large increase in the production of silver, notwithstanding the considerable decrease in the production of gold, is due to the large increase in the production of copper, with which most of the silver obtained in North Carolina is associated. This 1906 production consisted of 5,931 ounces of fine gold and 30,769 ounces of fine silver.

The largest production of gold was from Montgomery County, with Cabarrus second. The largest production of silver was from Rowan, and the second largest from Person, both of these counties also being the largest producers of copper. There is given in the following table a rough estimate of the production of gold and silver in 1905 and 1906, by counties, which will illustrate the distribution of the production throughout the State:

PRODUCTION OF GOLD AND SILVER IN 1905 AND 1906 BY COUNTIES.*

County.	1905.			1906.		
	Gold.†	Silver.†	Total.†	Gold.	Silver.	Total.
Burke -----	\$ 1,000	\$ 15	\$ 1,015	\$ 550	\$ 7	\$ 557
Cabarrus -----	22,836	53	22,889	17,500	50	17,550
Catawba -----	3,500	81	3,581	6,600	110	6,710
Cleveland -----				1,000	10	1,010
Davidson -----	1,000	420	1,420	750	300	1,050
Franklin -----				8	600	608
Guilford -----	9,000	30	9,030	6,500	25	6,525
McDowell -----	500	10	510	800	12	812
Mecklenburg -----	4,200	12	4,212	3,500	15	3,515
Montgomery -----	61,000	1,600	62,600	60,100	1,500	61,600
Nash -----	2,000	6	2,006	1,300	5	1,305
Person -----				200	8,750	8,950
Rowan -----	7,200	17,600	24,800	7,000	19,000	26,000
Stanly -----	10,000	140	10,140	10,000	150	10,150
Union -----	4,948	29	4,977	5,000	35	5,035
Unknown -----	1,969	220	2,189	1,200	375	1,575
Total -----	129,153	20,216	149,369	122,008	30,944	152,952

* The gold and silver statistics have been obtained through the courtesy of Mr. George C. Roberts, Director of the Mint, Washington, D. C. The counties given in this table do not represent all the producing counties, but the production has been given as far as possible to the principal producing counties and the balance is given as "Unknown." This latter undoubtedly includes a dozen or more counties.

† Coining value.

There is given in the next table the value of the gold and silver production in North Carolina for the years 1882 to 1906, inclusive.

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1882 TO 1906.*

Year.	Gold.	Silver.	Total.
1882 -----	\$190,000	\$ 25,000	\$215,000
1883 -----	167,000	3,000	170,000
1884 -----	157,000	3,500	160,500
1885 -----	152,000	3,000	155,000
1886 -----	175,000	3,000	178,000
1887 -----	225,000	5,000	230,000
1888 -----	136,000	3,500	139,500
1889 -----	145,000	3,878	148,878
1890 -----	118,500	7,757	126,257
1891 -----	95,000	6,465	101,465
1892 -----	78,560	12,671	91,231
1893 -----	53,600	17,325	70,925
1894 -----	46,594	455	47,049
1895 -----	54,200	520	54,720
1896 -----	44,300	646	44,946
1897 -----	34,600	388	34,988
1898 -----	84,000	905	84,905
1899 -----	34,500	388	34,888
1900 -----	44,653	15,986	60,639
1901 -----	60,410	34,023	94,433
1902 -----	93,650	30,212	123,862
1903 -----	113,604	16,907	130,511
1904 -----	123,924	19,133	143,057
1905 -----	129,153	20,216	149,369
1906 -----	122,008	30,944	152,952

* Coining value.

COPPER.

A thorough investigation is now being made of the copper mines and copper deposits of the State, which will be published briefly in the Economic Paper on the Mining Industry for 1907, and will be published in detail in a volume on the Copper Deposits of North Carolina.

The work on the copper deposits of Swain County, which occur in the Hazel Creek and Eagle Creek areas, has been concluded and a short description of their geology by Mr. F. B. Laney is given here.

COPPER DEPOSITS OF SWAIN COUNTY.

Rocks of the area.—The rocks of this region may be described under four divisions: Slate, conglomerate, graywacke, and igneous rock, probably a diorite, although possibly a gabbro.

The slate is probably the oldest of all the rocks of the region. It is a very dense black slate and usually contains varying amounts of iron sulphide, probably pyrite, although it is possible that some of this mineral may carry copper.

This slate is met with for the most part in the vicinity of Briar Knob, and extends from about $\frac{1}{4}$ mile east of Briar Knob along the top of the Smoky Mountains to a short distance east of Thunder Head; thence in an irregular line to Meadow Gap; thence irregularly northeastward to the point of beginning. In many places along the streams in this area the slate is stained with iron oxide, sometimes resembling gossan, and a few of the springs in the area show decided evidence of decomposing sulphides, the rocks through which they issue being stained with iron oxide and the waters having a decided "sulphur" taste.

From the examinations thus far made of the sulphide ore in the slates, it seems that it is only iron sulphide, and if this be true, it will probably not be worth while to spend any time in prospecting the slate area, since it is present only in small quantities and as such is worthless.

Another noticeable feature of this slate is the presence of numerous quartz veins, usually small, although rarely quite large. These veins usually follow in trend the schistosity of the slate, though often they follow one or more of the numerous sets of joints in the rock. In width they vary from less than one inch to perhaps 6 feet. The

large veins, however, are very few in number. Only two or three were noticed, and these were on the top of the Smoky Mountains immediately above "Fire Scald," at the head of Bone Valley Creek. One would expect to find sulphide ores associated with these quartz veins and in a few instances this is true, but a careful examination of the larger veins failed to disclose any sulphides. The sulphide ores found associated with the quartz veins were usually with the smaller veins and were apparently only sulphide of iron.

In most localities in the western part of North Carolina these quartz veins usually carry a very small amount of gold—only a few cents per ton—and some gold-bearing specimens are reported to have been picked up in this region. However, as careful a search as could be made in the field failed to show anything of this kind. Still it is possible that an assay of some of this quartz would show traces of gold, but probably only mere traces, since the conditions are apparently not favorable for a deposit of this metal.

Immediately overlying the slates and exposed as a rule only on the higher ridges and "tops" are the conglomerates. These conglomerates are almost invariably fine-grained and apparently pass into the ordinary graywacke—a shaling micaceous sandstone.

The pebbles of these conglomerates consist for the most part of small subangular to well-rounded pieces of a clear quartz, which in many instances has a delicate blue tinge of greatly decomposed feldspar, and of larger fragments of granite which have not disintegrated. This rock is usually quite massive, but in many instances is more or less "platy" or schistose. It contains few or no traces of the valuable ores and is considered a barren formation.

Overlying the conglomerates and apparently in many instances grading imperceptibly into them, come the rocks designated as graywackes, which are the underlying rocks of the greater portion of the territory surveyed—about nine-tenths of it.

This graywacke is by no means uniform in character; and on the one hand passes gradually into a conglomerate, which cannot be distinguished from the first mentioned conglomerate, and on the other, into a dense, fine-grained, more or less impure sandstone, and often into a typical dark-colored shale or slate. Thus, a section made across the edges of this graywacke formation should show possibly a bed of medium to fine-grained conglomerate which would grade into a bed of sandstone similar to that just mentioned, this in turn pass-

ing sometimes abruptly and sometimes by gradual gradation into a stratum of more or less impure slate or its altered equivalent, schist. If this section be continued to any distance the condition just mentioned, with the possible omission of the conglomerate belt, will be found to repeat itself, thus giving a series of soft, slaty or schist-like strata interbedded with denser, heavier, more massive beds of typical graywacke.

These graywacke beds are also intersected by numerous quartz veins in the same manner as were the slates, the veins, however, being more numerous and having a wider distribution than in the slates.

The beds or strata all have a general northeasterly trend or strike roughly parallel with the general trend of the great mountain ranges, the direction of the trend varying from N. 20° E. to N. 80° E., averaging perhaps N. 45° or 50° E. They also dip toward the southeast at angles varying from 20° to 80° , averaging about 60° .

These beds all show the effects of the intense mountain-building forces—dynamic metamorphism—which they have undergone in that they are now broken, folded and faulted, and in many places rendered highly schistose. The beds which have suffered most from this dynamic activity are, of course, the weaker strata of slaty material which lie between the heavier beds of massive sandstone or conglomerate. These are often found to be mashed and folded, knotted and contorted in a most complex manner, while the beds immediately above and below them are often only slightly affected, and thus form “walls” between which the slaty or schist-like beds lie.*

These beds of slate, having been mashed and broken to a greater extent than the other beds, have furnished easy channels for the circulation of underground waters, and hence always show more of the sulphides and other metallic minerals, also of quartz veins, than the other strata. Thus it is when other conditions have been favorable for its deposition that we find the deposits of the copper ores—copper-bearing iron sulphides—in these beds of “slate.”

The igneous rock referred to in the beginning of this report is probably a diorite or a gabbro-like diorite—at least a dark-colored basic rock of this type—in the form of a dike varying in width from 25 feet to probably 125 feet. This rock was traced by a series of irregular and disconnected outcrops and boulders and by a peculiar

* The prospectors and people of the region speak of these beds of schist or slate as “slate,” and of the heavier and denser beds “walling” them as “granite.”

soil which results from its decomposition, from Flint Gap, near Ekowah Branch, northeastward to a point on Proctor's Creek, about $\frac{1}{2}$ mile above its junction with Hazel Creek. It is also known to extend northeast to the Matt Crisp diggings, near Siler's Bald, where it is found outcropping in the cliff immediately above the little cabin at which the prospectors stopped while working at these diggings, and while it was not found west of Flint Gap, sufficient evidence was found to warrant one in asserting that it does extend southwest from this point for a number of miles. Thus it extends not as a continuous and unbroken line, but as a series of disconnected outcrops with numerous intermissions from a point on Eagle Creek, northwest of the mouth of Ekowah Branch, to a point on the Smoky Mountains near Siler's Bald—a distance of 15 to 20 miles.

The general trend or strike of this dike is approximately N. 50° E., but since it follows the strike of the country rock, which shows more or less variation from the average direction of trend, it also varies somewhat in the direction of its strike. There are also one and probably two abrupt breaks in it, probably caused by faulting. The most prominent of these occurs near the mouth of Mill Branch. Beginning at a point about one thousand feet southwest of Deep Gap, in the Forester Ridge, the dike may be traced without interruption to a point about $\frac{1}{4}$ mile north of the mouth of Mill Branch, at which place it ends abruptly. If, from the termination of the dike, one goes directly south about $\frac{1}{4}$ mile, it is again met with and may then be followed northeastward along its usual trend for a distance of nearly $\frac{3}{4}$ mile. This break in the dike is due either to close folding or to a displacement resulting from faulting. Indications in the immediate vicinity seem to point to the latter as the cause. The other probable fault is somewhere between the Everett Mine and Sugar Fork Gap, but could not be definitely located.

This dike rock is regarded as the most important geological feature of the district, for throughout its course the rock in near proximity to it always presents more or less indications of mineralization, containing sulphides, the product resulting from their decomposition and quartz veins; and it is along the trend of this dike that all the known authenticated deposits of copper ores occur, these ores apparently lying a short distance, from 50 to 300 feet, southeast of the dike. Thus it would seem that the dike bears some important relation to the deposition of the copper ores.

Whether this igneous rock has been the source of the copper ores which have penetrated the "slates" along its trend, or whether the fractures in the rocks along which it was intruded have been the channels through which mineralizing solutions have come up from lower depths, there is not sufficient evidence to state. However, the data collected so far seem to indicate that the igneous rock has been the source of the copper ores, since in one locality, where the dike is crossed by Mill Branch, it contains numerous particles of a mineral which is apparently chalcopyrite, which is the copper ore at the Everett Mine, and which has also been found in other places along the trend of the dike. Many specimens of this rock were carefully collected, especially at the above-mentioned point, and careful chemical and microscopic examinations will be made of these.

The ores of the area.—The ores of this area are for the most part only the commoner ores of copper and iron, although there are found a few other ores usually associated with those of copper. The following is as complete a list of the ores of the area surveyed and their places of occurrence as it is possible to make:

Native or metallic copper. This mineral is found in small quantity at the Everett Mine. It is a secondary mineral and has resulted from the alterations of the sulphide ores.

Chalcopyrite (copper-iron sulphide). This is the principal and most important copper ore of the district and is probably the ore from which all the other copper-bearing ores and minerals of the district have resulted. It occurs at the Everett and Westfeldt Mines, at the diggings in the vicinity of Siler's Meadows, on Dillie Welch's farm near Soapstone Gap, at Mill Branch where it crosses the diorite(?) dike, at the Phil Myers diggings on Ekowah Branch, and at the Cook prospect on Eagle Creek, and also possibly at the old Calhoun diggings on Briar Knob. It is reported to occur at a number of other points along the trend of the dike, but these are the only places where it was found during this survey.

Tenorite, "black copper" (a black oxide of copper). This mineral, which is one of the richest of copper ores, occurs in small quantity at the Everett Mine. It is a secondary mineral which has resulted from the alteration of the sulphides of copper and is usually met with in the mines at or near the level of ground water.

Malachite (a green carbonate of copper). It occurs in small quantity in the oxidized portions of the ore body in the Everett Mine.

Azurite (a blue carbonate of copper). This ore occurs in the Everett Mine in the same position as does the malachite, but is less frequently met with. These two carbonates are both secondary minerals resulting from the alteration of the sulphides. They occur in such small quantities in this region that, as ores, they are of no value. However, the green and blue stains due to their presence in or on the rocks are valuable guides in prospecting.

As to the manner of occurrence of these ores of copper, it is believed that the copper deposits do not represent fissure veins, but that they represent a replacement of the "slates" by the original sulphide ores. This has taken place along fractures, joint planes of schistosity or other structural fractures of the rocks which would have been favorable for the circulation of the mineralizing solutions.

In regard to the percentage of copper in the "copper veins" of this area, the work done thus far does not give satisfactory data for a very definite statement. However, it is probable that it will be low, somewhere between 3 per cent. and 6 per cent. (Reports, some of them not reliable, from the Everett Mine, show that, while some of the ore is very rich, the average will not run much over $3\frac{1}{2}$ or 4 per cent. of copper, with small though varying amounts of gold and silver).

Iron does not occur in workable deposits in the area covered by this report.

Pyrite (sulphide of iron). This occurs widely disseminated in small quantities in all the rocks of the area,—especially in the Briar Knob slates. It is of no value in the quantity in which it apparently occurs.

Limonite (a hydrated oxide of iron). This is the iron ore which accompanies the sulphides. It results from their oxidation and is the iron ore of the gossan of the upper portion of the "copper lead."

Galena (sulphide of lead) occurs in small quantities in association with the copper ores at the Everett and Westfeldt Mines and in the prospects near Siler's Bald. It occurs in such small quantity that as an ore it is worthless.

Sphalerite, "black jack" or zinc blende (sulphide of zinc). This mineral also occurs in small quantities associated with the copper ores at the localities mentioned above. The quantity is so small that it is of no value.

Gold. This metal is reported to occur with the copper at the Everett Mine. The quantity is of course small, but it is of value when worked with the copper ores. If it is true that gold is found at this mine, it will probably be met with at other places with the copper ores. It is also said to occur in some of the quartz veins—one crossing Bone Valley Creek just below Kims Hall's house, and one in an old field a few hundred yards above J. E. Coburn's house, are both said to be gold-bearing. Careful examinations of both of these in the field disclosed but little evidence in favor of the reports, but it may be that further and more detailed examination, assays, etc., would confirm the statements.

Silver. This metal is also said to occur in small amount with the copper ores at the Everett Mine.

Rutile (an oxide of titanium). This mineral was found in small quantity in the bed of Rutile Branch, which flows into Big Flats Branch just above Mrs. Hall's house. It is present apparently in small quantity only, and hence is probably of no value.

Suggestions and recommendations.—The areas which this field of work would seem to indicate as being favorable for prospecting are the small "slate" areas described as occurring on the head waters of Bone Valley Creek and the territory immediately adjoining the diorite(?) dike. The presence of sulphide and the stains resulting from their oxidation and the numerous quartz veins in the "slate" area seem to warrant one in saying that it might be well to examine this area in closer detail. However, it is believed that the sulphides causing these stains are of pyrite, the iron sulphide, and hence probably worthless, but such may not be the case. Therefore, a certain amount of detailed work in the area might not be amiss.

The most favorable of all is the area mentioned above as adjoining the dike. It is in this region, as has been stated, that the true and valuable copper ores of the region have been found thus far and the rocks in near proximity to practically all the exposures of this dike always contain unmistakable indications of sulphide and usually show varying amounts of copper-bearing sulphide, chalcopyrite, although in most places it would seem that this latter mineral is present only in small quantities. However, the amount of exploratory work which has been done in this district up to the present time

would warrant no very definite statements as to the amount of this mineral that future exploration might disclose.

As to the distance from this dike to which the prospecting should be carried, one will have to be guided by the character of the rocks themselves; but from the observations made thus far it would seem that the most favorable area is not more than a few hundred feet southeast of it, which is the direction of the dip of the rocks. It would also seem that it would hardly be worth while to continue this detailed examination to a distance greater than one-quarter of a mile on either side of the dike.

PRODUCTION.

The production of copper in 1906 was from Rowan and Person counties and amounted to approximately 11,729 tons of ore, of which the value of the copper contents was \$135,829. This is an increase of \$55,829 in value, and of 214,887 pounds in quantity as compared with 488,888 pounds valued at \$88,000, the production of 1905. In the following table there is given the production of copper in North Carolina from 1900 to 1906, inclusive:

PRODUCTION OF COPPER FROM 1900 TO 1906.

Year.	Crude Ore Mined.	Copper Produced.	Value.
	<i>Tons.</i>	<i>Pounds.</i>	
1900 -----	6,948	-----	\$ 41,600
1901 -----	10,398	512,666	76,900
1902 -----	16,741	1,417,020	212,553
1903 -----	4,106	458,133	67,037
1904 -----	4,250	305,000	36,600
1905 -----	10,000	488,888	88,000
1906 -----	11,729	703,775	135,829

IRON.

During the past year there was considerable development work done on the Ashe County magnetic iron ore deposits by the Virginia Iron and Coal Company, of Bristol, Tenn. Its work has shown this vein to be continuous for over a mile and a half and crossing the north fork of New River three times in this distance. A railroad route has been surveyed to these deposits from the Norfolk and Western Railroad, and it is expected that this will be built in the near future.

The pig-iron obtained from these Ashe County deposits is of a superior quality and is very similar to the celebrated iron obtained from the Cranberry Mine, Mitchell County.

PRODUCTION.

The production of iron ore in North Carolina during 1906 amounted to 56,057 tons, valued at \$75,638, and was obtained from Mitchell County. As compared with the production of 56,282 long tons valued at \$70,352, the 1905 production, it is a decrease of 225 tons in quantity, but an increase of \$5,286 in value. In the following table is given the production of iron ore in North Carolina from 1900 to 1906, inclusive:

PRODUCTION OF IRON ORE IN NORTH
CAROLINA, 1900-1906.

Year.	Amount Long Tons.	Value.
1900 -----	21,000	\$ 42,000
1901 -----	2,578	4,997
1902 -----	34,336	52,771
1903 -----	82,851	78,540
1904 -----	64,347	79,846
1905 -----	56,282	70,352
1906 -----	56,057	75,638

TIN.

Although there was a large amount of development work done on the tin deposits of North Carolina during 1906, and considerable ore mined, yet there was no ore shipped or sold. The Piedmont Tin Mining Company began the erection of a mill to treat the ore from its mine near Lincolnton, Lincoln County. These deposits have been described in detail in Economic Paper No. 11 and Bulletin No. 19.

ABRASIVE MATERIALS.

PRODUCTION.

Under this head are included corundum, garnet and millstones, but in 1906 the only abrasive material produced was millstones, which were quarried in Rowan County. There were 205 pairs of millstones valued at \$4,100 produced in 1906, as compared with 196 pairs valued at only \$2,652 in 1905. There was a small production of garnet and corundum in 1905, but none was reported during 1906, so that the production of millstones represents the total value of abrasive materials during the latter year. In the following table there is given the production of abrasive materials from 1901 to 1906, inclusive:

PRODUCTION OF ABRASIVE MATERIALS, 1901-1906.

Year.	Corundum.		Garnet.		Millstones.		Total Value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	<i>Tons.</i>		<i>Tons.</i>		<i>Pairs.</i>		
1901 -----	325	\$ 48,840	775	\$ 43,000	-----	\$-----	\$ 91,840
1902 -----	-----	-----	260	10,040	50	1,425	11,465
1903 -----	-----	-----	*403	12,250	63	902	13,152
1904 -----	-----	-----	*202	6,586	208	6,500	13,086
1905 -----	†1,150	9,000	-----	-----	196	2,652	11,652
1906 -----	-----	-----	-----	-----	205	4,100	4,100

*Including production of corundum.

†Including production of garnet.

MICA.

The mica deposits of western North Carolina have for a number of years furnished from two-thirds to three-fourths of all the mica produced in the United States. Investigations have been carried on in relation to these deposits for a number of years and there is now being prepared by the State Geologist and Mr. Douglas B. Sterrett a volume on Mica and the Pegmatites of Western North Carolina, which will take up in detail a description of all the known mica deposits in the State; its occurrence and associated minerals; origin; method of mining, and uses. A short preliminary statement of the investigation on these mica deposits, which has been compiled by Mr. Sterrett, is given in this report. For further information on mica the reader is referred to the publications given in the foot note.‡

During the past three years the mica industry in North Carolina has become stronger and there has been a large increase in the production.

‡PRATT, J. H. The Mining Industry in North Carolina, annual publication of North Carolina Geol. Survey, 1900-1904.

Production of Mica in the United States: Mineral Resources for 1905 and several years preceding, U. S. Geol. Survey. Especial attention is called to the report by J. A. Holmes in the volume for 1898 (Twentieth Ann. Rept., pt. 6, continued, 1899, pp. 691-707).

ELLIS, R. W. Mica Deposits in Canada: Mineral Resources of Canada, 1904, Canada Geol. Survey.

CIRKEL, FRITZ. Mica, its Occurrence, Exploitation, and Uses, Mines Branch, Dept. Interior, Canada, 1905.

COLLES, G. W. Mica and the Mica Industry: Jour. Franklin Inst., Philadelphia, vol. 160, 1905, pp. 275-294. Reprinted in book form in 1906.

MICA DEPOSITS OF WESTERN NORTH CAROLINA.

BY DOUGLAS B. STERRETT.*

DISTRIBUTION AND GENERAL CHARACTER.

Mica-bearing pegmatites occur over a wide area in North Carolina, roughly bounded by the State lines on the northeast and southwest. This area extends about 50 miles southeast of the Blue Ridge and northwestward nearly to the Tennessee line. (See fig. 1.) Mica mining has been carried on in eighteen or more of the counties included in this area. The largest producers have been Mitchell,

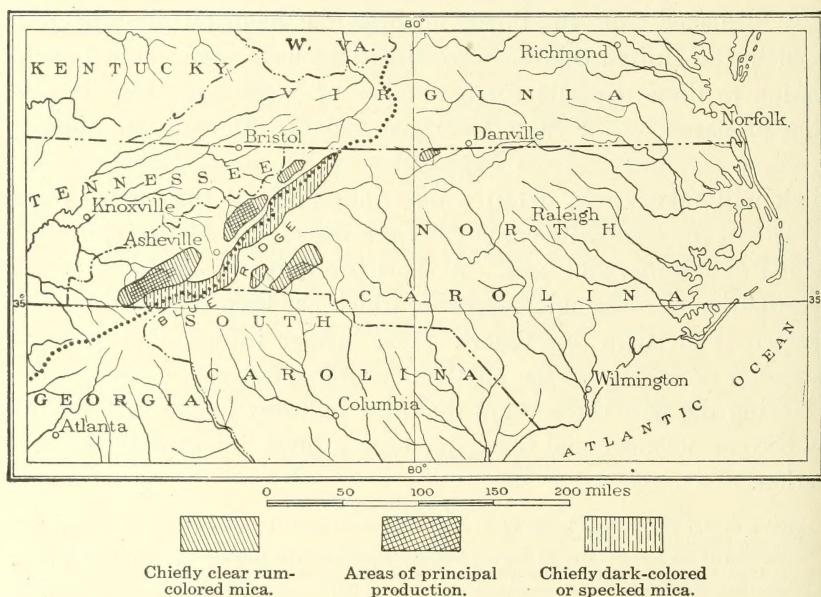


FIG. 1.—Map showing areas in North Carolina in which mica has been mined.

Yancey, Macon, Jackson, Haywood, Ashe, and Cleveland counties. Good deposits have been discovered in other counties, and some have yielded considerable mica.

* Most of the mica mined comes from three belts in the western part of the State. These may be called the Cowee-Black Mountain belt, the Blue Ridge belt, and the Piedmont belt. The first of these extends nearly through the State, parallel to and near its northwestern border. It lies northwest of the Blue Ridge and includes part of

* First published in Bulletin 315, U. S. Geol. Survey, 1907, p. 400.

Macon, Jackson, Transylvania, Haywood, Buncombe, Yancey, Mitchell, Watauga, and Ashe counties. The second belt follows the Blue Ridge through the State and extends several miles to the southeast among the foothills of the ridge. It is of relatively small importance as compared with the other two. The Piedmont belt lies wholly in the Piedmont Plateau, southeast of the Blue Ridge, mainly in Cleveland, Lincoln, Burke, and Stokes counties. Commercial mica deposits have not been found in unbroken succession through the whole length of any one of these belts.

The quality of the mica obtained from different localities varies considerably. In general it may be said that the mica of the Cowee-Black Mountain belt is chiefly clear and of light color (as a rule "wine" or "rum"). That from the Blue Ridge belt has a dark smoky-brown color and much of it is more or less "specked." In much of the Piedmont belt the mica is of good quality and similar to that of the Cowee-Black Mountain belt. Of course there are exceptions to these characteristics, in part connected with geologic conditions which are mentioned in another place (page 87).

The Cowee-Black Mountain mica belt is in the heart of the Appalachian Mountains. The deposits lie at various elevations between 2,000 feet above sea level and that of the highest mountains, or over 6,500 feet. Some are high up on the rugged slopes, where the soil covering is thin. Others are on the gentle slopes of the valleys, covered by deep residual clays. Much the same could be said of the Blue Ridge belt, though the elevations are not so great. In marked contrast with the high relief of the mountain region that includes these belts is the topography of the Piedmont Plateau, southeast of the Blue Ridge. The general elevation in the mica-bearing areas of the plateau belt is from 1,000 to 1,500 feet above sea. Though typically a plateau, it is more or less dissected by river and creek valleys 200 or 300 feet deep.

The rainfall in western North Carolina is heavy, and, as the climate is not severe, vegetation flourishes, and large areas are covered with dense forests. The residual soil covering due to rock decay is in many places very thick, especially where the slopes are gentle and the removal of decomposition products is slow. These features combine to make the discovery of mica deposits difficult.

GENERAL GEOLOGY.

The mica-bearing pegmatites of North Carolina are found chiefly in rocks of Archean age, and are practically confined to mica, garnet, cyanite, hornblende, and granite gneisses and schists. Other rocks in the region are granites, diorites, and peridotites, also of Archean age, as well as younger granites, volcanics, and sediments. The metamorphism, folding, and faulting of the gneisses and schists have been extreme. In most of the Archean rocks it is difficult to determine the original nature of the formations, since much of the sedimentary bedding and igneous texture has been destroyed by mashing and recrystallization.

The majority of the mica deposits occur in two formations as mapped by Keith,* namely, the Carolina gneiss and Roan gneiss. The Carolina gneiss includes most of the gneisses and schists mentioned above that are not hornblendic in composition. The Roan gneiss is composed of hornblende gneiss and hornblende schist with smaller beds of mica gneiss and mica schist included. Large areas of the other rocks mentioned above are mapped as separate formations. These are principally granites and granite gneisses of Archean age. In the mica regions by far the most important formation is the Carolina gneiss. It extends from the northwestern side of the Cowee-Black Mountain belt to and beyond the southeastern side of the Piedmont belt. In a northeast-southwest direction it extends far beyond the State boundaries. The age of the Carolina gneiss is greater than that of any other formation in the region. Igneous rocks of later epochs have been intruded into this gneiss, which has been gashed and cut by them into irregular-shaped masses, in many places forking out into long tongues or occurring as long, narrow streaks in the intrusives, or vice versa. This feature is common to both the granite intrusives and the Roan gneiss, which is the next oldest formation of the region. Rocks of still later age, as Cambrian sediments, have been metamorphosed into gneiss and schist and folded with the older formations by movements associated with the Appalachian uplift. The Carolina and Roan gneiss formations have been interbanded with and cut at all angles by numerous streaks of granitic or pegmatitic material. These range from a fraction of an inch upward in thickness, and locally pass into mica-

* *Geologic Atlas U. S.*, Asheville (116), Cranberry (90), Mount Mitchell (124), Nantahala (143), Pisgah and Roan Mountain folios, U. S. Geol. Survey.

bearing pegmatites. In some places pegmatization is so thorough that mica gneisses become strikingly like granite gneisses. This is especially characteristic of the Carolina gneiss in the Piedmont region.

The study of the geology in this region is exceedingly difficult, because the rocks have been so intensely folded, faulted, and metamorphosed. The enormous amount of erosion the region has undergone and the present depth of atmospheric decomposition also complicate the task.

OCCURRENCE OF MICA.

Mica deposits of commercial value in this State are confined to pegmatites. These rocks vary considerably in form, some being typically lenticular in shape and others more or less persistent in length. The lens-shaped bodies are generally conformable with the schistosity of the inclosing rock. They may lie in the same line of bedding or schistosity and be connected by smaller streaks or stringers of pegmatite or by mere seams in the rock. Many of them, on the other hand, lie in planes of schistosity more or less separated from one another and form parallel or overlapping bodies. In cross-section some of these lenses are short and bulky, with a length only two or three times the thickness; others are long and tapering, and may constitute simply a bulge in a sheet of pegmatite. In most places the schistosity of the inclosing rock bends around the lenses.

Some of the more persistent pegmatites occupy straight fissures that hold their direction for some distance. Elsewhere they are folded with the country rock or bent and twisted into various shapes. Many are more or less conformable with the bedding of the gneisses and schists. In the latter case they are, in a large measure, subject to the deformations of the country rock. In many places, however, the pegmatites are conformable for some distance, and then branch out, cutting from one layer to another across the bedding. Locally, there is an elbowing or bulging-out on one wall, without a similar irregularity on the other wall of the pegmatite. It is not uncommon for pegmatite masses to cut across the country rock for long distances.

Though pegmatites have been worked for mica in regions of hornblende gneiss and hornblende schist, where they are directly associated with those rocks the majority of the deposits are in small biotite-gneiss or schist masses included in the hornblende areas.

Where the pegmatite is in contact with hornblende gneiss, the latter may be highly biotitic.

Pegmatites occur in irregular masses, streaks, lenses, augen, or balls, some of them having no visible connection with other pegmatite bodies. They range from a fraction of an inch up to many yards in thickness. The limit of size below which they cannot be profitably worked for mica might be placed arbitrarily at from 1 to 2 feet for rich and regular "veins." In the very large pegmatites the mica is not, in general, evenly distributed through the mass, but is richer in one portion than another, so that the entire bulk of the rock does not have to be removed in mining. The irregularities of pegmatites and the consequent difficulties in mining mica from them are well illustrated in road cuts or similar excavations where pegmatized gneiss or schist has been exposed. The lenticular shapes, pinching and swelling, crumpling, folding, and faulting to be observed in these cuts are found to be nearly duplicated in larger pegmatites opened for mica. As stated before, these smaller masses may grade into those containing mica of commercial value. Here and there the two can be seen at the same locality.

Horses or inclusions of wall rock are common in pegmatites. Some of them are in the form of bands or sheets parallel to the walls, and the schistosity of these bands is also parallel to the walls. They range from an inch or two up to a couple of feet in thickness, and their length may be many times their width. Elsewhere they occur as irregularly shaped masses, from a few inches up to several feet thick. If the bedding has been preserved, it may lie at any angle with that of the inclosing wall rock. In some places the horses are partially pegmatized by streaks of pegmatite ramifying through them and the development of considerable feldspar and quartz through their mass. In such places no sharp line can be drawn between the point where the pegmatite ceases and the original horse begins.

Pegmatite is closely allied to granite in composition. As in granite, the essential constituents are feldspar and quartz, with more or less mica and other accessory minerals. Though hornblende is a rather common mineral in granite, it is less so in pegmatite. Orthoclase and microcline are the most common varieties of feldspar found in pegmatite. In many places, however, a variety of plagioclase, either albite or oligoclase, makes up part or all of the feldspar component. The feldspar occurs in masses and rough crystals with a diameter of sev-

eral feet. In the old Mart Wiseman Mine, near Spruce Pine, Mitchell County, orthoclase crystals 2 by 4 feet and larger have been cut through. From their whole rectangular cross-section, as exposed in the walls of the tunnel, a simultaneous reflection of light is obtained from the cleavage faces.

Quartz assumes various forms and positions in the pegmatite. In many places it bears much the same relation to the feldspar and mica as in granite, the three minerals being thoroughly mixed with one another; but the individual grains are many times larger than in ordinary granite. Not uncommonly the quartz and feldspar assume a graphic-granite texture in a portion of the pegmatite. Another common feature is the occurrence of large separate masses of quartz occupying various positions in the pegmatite. Such quartz masses may be irregular in form and but little influenced by the shape of the pegmatite or inclosing walls. Generally, however, they occur in bands or sheets lying parallel to the walls. There may be one or more of these quartz bands constituting varying proportions of the pegmatite. Their thickness ranges from a fraction of an inch up to 6 or more feet. Many of them are lenticular in shape, the length varying from four or five to twenty or more times the thickness. In numerous places these quartz streaks or veins are persistent through the whole length of the pegmatite exposed. Some inclose feldspar or mica bodies; others do not. The quartz of these segregations is massive and generally granular, though locally crystallized. In the latter case it may be translucent or clear and of a dark smoky or light color. It is generally rather pure and does not contain feldspar or mica in any quantity.

Muscovite is the common mica of pegmatite and is the only variety mined in North Carolina. Biotite occurs in some quantity in a few deposits, and in smaller amount in many others. Where muscovite and biotite occur together in a deposit, the muscovite is generally clear and of good color. It is not unusual for the two to occur in intergrown crystals with a common cleavage plane. Again, mica from deposits in rock formations where the ferromagnesian minerals are abundant, as hornblende or biotite gneiss and schist, is generally found to be clear and of light color. Where the pegmatite is closely associated with or occurs in granite with a paucity of the ferromagnesian minerals, the mica is generally of dark color and much of it "specked." The true color of mica is best observed in sheets from

one-sixteenth to one-fourth inch in thickness when examined in transmitted light.

The mica occupies various positions in the pegmatite. Where the rock has a typical granitic texture, the mica may be found evenly distributed through it. More commonly the larger crystals will be found either in clusters at intervals through the "vein," in places connected by streaks of small crystals, or collected along one or both walls of the pegmatite, with some of the crystals partly embedded in the wall rock. Where there is a quartz streak within the pegmatite, the mica occurs on either or both sides of it, being in places partly embedded in the quartz or occupying any of the positions noted above in the remaining portion of the pegmatite, which generally is composed largely of feldspar.

ASSOCIATED MINERALS.

Over forty different minerals have been found in the pegmatites of North Carolina.* Besides muscovite mica, several others of commercial importance are found, including quartz in large masses, feldspar in considerable quantity, kaolin in large deposits, beryl of several gem varieties, zircon, uranium minerals carrying radium, samarskite, and columbite. Most of the rare minerals, as gem beryl, columbite, those of uranium, etc., are found in Mitchell and Yancey counties, though beryl of gem quality is found also in many other counties. The beryls from the pegmatites have furnished handsome gems, as emerald, aquamarine (sea-green and blue) and the golden variety. The potash feldspar removed in mica mining should prove of value in the manufacture of pottery. Kaolin results from the decomposition of the feldspar of the pegmatites by weathering. In the majority of the pegmatites of North Carolina that have been opened for their valuable minerals the feldspar is found to have partially or entirely altered to kaolin from the outcrop down to depths varying from a few to 100 feet or more. In this way valuable deposits of kaolin have formed.

DESCRIPTION OF MINES.

It is not intended to give under this head a description of all the mica mines in North Carolina, but only a few which represent typical examples of various pegmatite formations. All of the mines will

*Pratt, J. H., Mining Industry in North Carolina in 1901: Economic Paper in North Carolina Geol. Survey No. 6, 1902.

be described in the volume on "Mica and the Pegmatites" that is now in preparation.

Milton English and Neighboring Mines.

The Milton English Mine, about one mile northeast of Plumtree, Mitchell County, furnishes one of the most typical examples of pegmatite lens formation known. The pegmatite lies in one of the smaller biotite-gneiss bodies included in the large area of hornblende gneiss which forms the country rock of the region. The rocks as exposed in the mine are approximately horizontal, with only a few gentle monoclinal folds dipping southward.

A tunnel has been driven in over 450 feet in a southerly direction, from which drifts have been run off, both to the east and west, for distances varying from 25 to 60 feet. The main tunnel was carried back by a series of rooms, some being about 25 feet wide, where the "vein" was found sufficiently rich. The size and shape of these rooms depended on the pegmatite lens that was removed for mica as they were being made. In some places all of the pegmatite had been removed on one side of the room or the other. In others, however, a streak a few inches thick was left in the walls, showing where the lens had pinched down from several feet (the height of the room) to a few inches. The structure of the pegmatite is strikingly illustrated in the walls and faces of the workings, where cross-sections of the lenses can be seen. Some are 6 to 10 inches thick and a couple of feet long; others are of much greater thickness (up to 5 or 6 feet) and of proportional or even greater length. These lenses overlap or lie parallel to each other. Many of them lie in the same strata of the gneiss, though separated by several feet. A thin seam or parting, locally containing a little pegmatite material, can generally be traced between two such lenses. Here and there the pegmatite occurs in sheets or streaks, which in places bulge out into lenticular form. These streaks may pinch down to mere threads, but when followed a little way open out into other lenses. The full thickness of the belt of overlapping and parallel pegmatite lenses and streaks is generally under 8 feet. The mica gneiss curves around swells and bulky parts of the lenses.

From the mouth of the tunnel the pegmatite outcrop has been traced both to the east and the west for some distance around the contour of the mountain side. A diabase dike, called "the iron bar" by the

miners, follows the pegmatite back as far as development work has been carried. It is very irregular, appearing in one place cutting into the pegmatite and then not seen again for some distance.

The texture and composition of the pegmatite are those of very coarse granite. The three constituent minerals are thoroughly mixed and have separated out in large masses. Even in lenses only 10 inches thick mica crystals 5 or 6 inches in diameter have been found. The quality of the mica is excellent. The color is a clear light "rum" when the sheets are about one-eighth inch thick. The lamination is perfect, and beautiful sheets for glazing purposes can be obtained. The yield for the amount of rock removed is satisfactory and contains a fair proportion of larger sizes.

Other mines have been opened to the southeast and east of the Milton English, apparently in the same formation. At the Johnson Mine, nearly two miles to the southeast, the pegmatite is included in a hornblende gneiss, lying nearly flat, biotitic near the contact and conformable with it. It is sheetlike in form, pinching down to a few inches and beyond swelling to several feet.

McKinney or Powdermill Creek Mine.

The McKinney is a new mine, about three miles northwest of Plumtree, on the north slope of a mountain south of Powdermill Creek. The work consists of an open cut nearly 100 feet along the strike of the "vein" and not over 15 feet deep in any part. Only the width of the pegmatite has been removed. This rock lies in a biotite-gneiss streak, a few yards north of its contact with the hornblende-gneiss formation, which is the country rock of the region. The pegmatite is conformable with the gneiss and strikes due east at the west end of the cut and about N. 80° E. in the eastern part. The dip is about 80° S. The average width is about 6 feet, though it increases to 8 feet or more near the middle of the cut. At one point, near the west end, the south wall elbows out, causing the pegmatite to pinch abruptly from 6 feet down to 4 feet. In general, however, the variations in size are more gradual. The pegmatite has been traced by prospect pits for some distance farther east.

The texture of the pegmatite is that of coarse granite, except for a width of a few inches along the contact, where it is very fine-grained and of dark color, thus being in marked contrast with the rest of the mass. The feldspar is chiefly a plagioclase. The mica is generally

disposed near one wall or the other, though some large blocks occur nearer the middle of the "vein." It has a rather dark brown color and part of it is somewhat "specked." It is fairly plentiful, however, and blocks of good size are frequently obtained.

Big Ridge Mine.

The Big Ridge Mine is about 6 miles east of south of Waynesville, Haywood County, high up on the southwest side of Lickstone Bald, at an elevation of about 4,500 feet. The mine is equipped with air drills and a steam pump. The mica-bearing pegmatite is conformable with the mica-gneiss country rock, and is folded with it into an anticline, the axis of which strikes about N. 80° E. and pitches 20° or more into the mountain side. The angle of the fold is not sharp, yet the legs dip about 45° a few rods from the axis. The workings consist of tunnels and drifts along the pegmatite, with stopes and raises between. On the north leg of the fold the "vein" has been removed for a depth of about 300 feet, but on the south it has been worked for only about 100 feet. The pegmatite is fairly regular in thickness and would probably average 8 feet through a large part of the mine. In certain places where the full width of the "vein" had been removed rooms 12 to 15 feet high were left. The greater part of the pegmatite has a coarse granitic texture. A peculiar graphic-granite texture has been observed in smaller portions of the pegmatite, caused by a parallel orientation of biotite plates in a feldspar-quartz matrix. A thin section cut from a piece of this nature showed, under the microscope, a semimicrographic arrangement of quartz in feldspar crystals. The feldspar is largely albite. A large amount of biotite, probably amounting to one-fourth or one-third of all the mica contained in the "vein," is found with the clear mica. In places the two form intergrowths with one another. Apatite, hornblende, and garnet are found as accessory minerals. The mica is of clear, light "rum" color and excellent quality. The mine has been worked for many years and has been a good producer. It is often closed during part of the winter, as it is found difficult to keep up sufficient steam to run the air compressor at such an elevation during the cold weather.

Cattail Branch Mine.

The Cattail Branch Mine is near the head of Cattail Branch, in Yancey County, about 5,500 feet above sea level and nearly a mile

southwest of Celo Mountain, the north end of the Black Mountains. It was discovered about two years ago by Silvers & Son and B. Roland, all of Yancey County. The developments consist of open cuts at three different points on the outcrop. The country rock is biotite gneiss. Near the pegmatite it is much flexed and folded, striking northeastward with nearly vertical folds. The pegmatite is in the form of an inclined trough with a horse-shoe or U-shaped cross section. The bottom of the trough pitches about 55° SW. and cuts directly across the country rock. The sides are nearly vertical and, at a little distance from the bottom of the trough, conform in a general way with the strike of the country rock. The thickness of the pegmatite varies from 3 feet in the curve of the horse-shoe to 20 feet or more some distance out from the curve. This includes horses or tongues of wall rock around which the pegmatite has forked. About 30 feet southwest of the curve the northwest arm is nearly 25 feet thick, the greatest thickness exposed. The "vein" must have bulged out abruptly to attain such a thickness at this point. It contains mica-gneiss bands or horses, from a few inches up to a maximum in one place of several feet in thickness, and oriented parallel to the walls. The southeast arm shows a similar bulging, being about 12 feet thick at a distance of 25 feet from the curve.

The texture of the pegmatite is very coarsely granitic. The larger portion of the mica is found in the interior of the pegmatite, though some occurs scattered along the walls. The quality is excellent and the color a beautiful "rum." The yield in larger sizes is good, and smaller sizes are plentiful.

Thorn Mountain Mine.

The Thorn Mountain Mine is on the south side of Thorn Mountain, about 3 miles south of Wayah Gap, in the Nantahala Mountains, Macon County. There are two mines about a quarter of a mile apart on this mountain. The one chosen for description is sometimes called the No. 2 Mine. The work consists of a good-sized open cut carried back about 40 feet on the strike of the pegmatite, and about 25 feet deep at the farther end. The country rock is pegmatized mica gneiss, which strikes about N. 50° E. and has a high northwest to vertical dip. The pegmatite is from 10 to 15 feet thick, and cuts to gneissic country rock with a strike of about N. 25° E. and a dip of 50° SE. (See fig. 2.) At least one horse of mica gneiss is in-

cluded in it and exposed near the bottom of the cut. This horse is a large one, with its schistosity turned at an angle to that of the wall rock. In the face of the cut, just below the top, the pegmatite either forks or, more probably, includes another horse of wall rock.

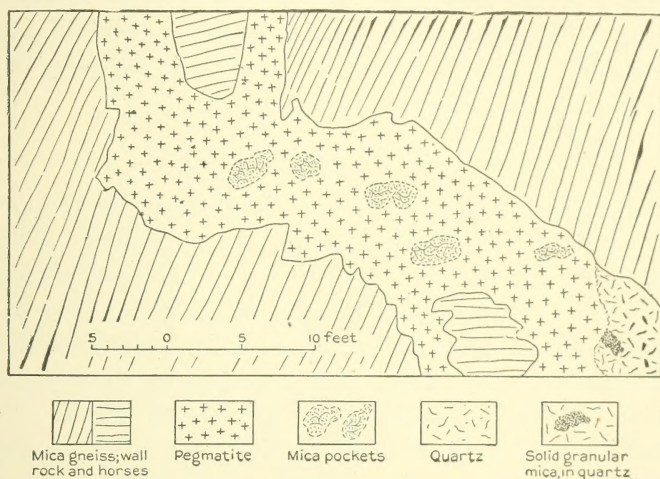


FIG. 2.—Section across pegmatite at Thorn Mountain Mine, Macon County, N. C.

The schistosity of this inclusion is also out of parallel with that of the walls. These horses are even more highly pegmatized than the country rock, and the lower one has a very irregular outline.

The texture of the pegmatite is that of very coarse granite. The mica does not seem to be confined to any one portion, but is found in bunches or pockets of crystals at varying intervals through the mass. It is said that in mining often several feet of barren "vein" would have to be removed before one of these pockets was encountered. They generally yielded a good quantity of mica, however. In the bottom of the cut on the southeast side a mass of quartz had been laid bare, but it was not sufficiently exposed to determine its relation to the rest of the pegmatite. An irregular band of solid mica composed of an aggregate of small crystals, one-eighth to one-half inch or more in diameter, was included in this quartz. It was 6 to 10 inches thick and 8 feet long. A little biotite is found with the muscovite at this mine. The two are in places intergrown, and in one specimen seen a sheet of black mica inclosed a rhombic-shaped plate of clear mica. The latter had very much the appearance of a fancy window in a dark wall. A

small amount of pyrrhotite carrying a little chalcopyrite is scattered through this quartz in lumps up to half a pound in weight.

This mine has not been worked for several years. The "vein" material that had to be removed was found to be exceedingly hard. The distance of the mine from any settlement made it difficult to obtain labor. The mica was reported to be fairly plentiful, however, and this combined with its light color and excellent quality ought to equalize any disadvantage due to location.

Mines in the Wayah Bald Region.

Four mines have been opened in the Nantahala Mountains on the east and northeast side of Wayah Bald, Macon County. These are the Turkey's Nest, Lyle Cut or Evans, Wayah Bald, and Raven Cliff. All but the Raven Cliff were examined, and since they have so many features in common, a description of one with reference to the other two will answer for all three. The Lyle Cut has been chosen for description. It has been worked by an open cut the width of the pegmatite and about 40 yards back into the side of the ridge leading eastward from Wayah Bald. The depth is nowhere over 35 feet.

The country rock is mica gneiss, which strikes N. 80° E. and dips 60° NW. The pegmatite cuts across the gneiss with a strike of N. 40° E. and a dip of about 70° SE. It is 7 feet wide in places, but pinches down to about 3 feet at the entrance to the cut. These variations in thickness are rather gradual and the deposit appears to be very regular. The strike and dip remain uniform as far as the rock is exposed in the cut. A persistent quartz streak of variable thickness and continuity occurs within and near the middle of the pegmatite. It varies from 10 inches up to 2 feet in thickness, and is present in the full height of the pegmatite exposed in the face of the cut. It has a peculiar banding parallel to its direction and the walls of the pegmatite. In hand specimens the texture is granular and the banding appears as alternating portions of more or less translucent and white quartz. Small mica plates lie in certain streaks or seams parallel to this banding. Under the microscope a thin section proved to be almost entirely composed of rather fine-grained quartz. The grains are angular and fit somewhat closely together. Some of them show evidence of moderate strain. Between crossed nicols a slight banding is apparent in certain directions by the extinction of the quartz grains. Parallel to this banding are two streaks of minute black particles, probably magnetite. These lie chiefly between sep-

arate grains of quartz, though some are included in the quartz grains. The quartz contains many inclusions. Some of them seem to be irregular cavities, with or without gas; others have a reddish color, and may be iron oxide which has worked its way from the pores between the grains into the cavities in the quartz.

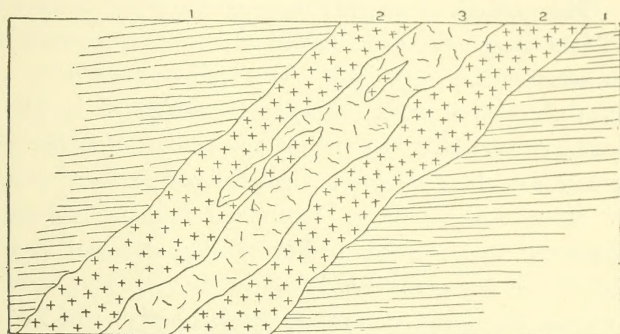


FIG. 3.—Pegmatite, $2\frac{1}{2}$ feet thick, at Wayah Bald Mine, Macon County, N. C. 1, Wall rock (mica gneiss); 2, pegmatite, mostly feldspar, quartz, and mica; 3, quartz.

The mica was reported to be plentiful in the feldspar-quartz streak between the quartz band and the wall rock. The color is a beautiful "rum" and the quality excellent.

In the other two mines the pegmatite cuts the mica-gneiss country rock, as in the Lyle Cut. There is also a regular quartz vein within the pegmatite. The mica occurs in a matrix, consisting mostly of feldspar with some quartz, between the quartz band and the walls. In the Wayah Bald Mine the quartz forks in one place, nearly enclosing a small mass of feldspar (see fig. 3), and in another part it completely envelops a mass of feldspar 3 or 4 inches thick. Banding of the quartz was not observed in the Wayah Bald Mine. Both mines produce "rum"-colored mica of the same excellent quality as that of the Lyle Cut.

All are old mines except the Wayah Bald, which is the only one that has been worked recently. It shut down, however, in the fall of 1906.

Horace Thompson Mine.

The Horace Thompson Mine is about $3\frac{1}{2}$ miles northeast of Fallston, in Cleveland County. It has been opened by half a dozen shafts with considerable tunneling from them. Much material has been removed, and owing to the decomposed nature of the rock formations and the probably scant timbering used, most of these workings have

fallen in and the ground above them has subsided several feet. The openings are within an area about 60 yards east and west by 20 yards north and south. The country rock is garnetiferous gneiss and schist. Cyanite is another important constituent in part of it. The garnets, which are up to $1\frac{1}{2}$ inches in diameter, weather out in the soil near the mine. The product of weathering consists chiefly of clay through which abundant fragments of hematite and tufts of cyanite impregnated with hematite are scattered. The strike of the rock near the mine is mostly east and west, swinging to northwest in places, and the dip is nearly vertical. In two of the shafts with their tunnels on the north side of the deposit (not yet fallen in) there were quartz ledges and streaks in the large kaolinized feldspar formation exposed. Blocks of mica several inches in diameter had been left in the roof of one of these tunnels lying in the feldspar between the wall and one of the quartz masses. Small blocks were included in the quartz itself. It seems probable that this pegmatite formation is limited in extent, for an opening made about 20 yards east of the main workings exposed a small pegmatite body 2 or 3 feet thick with a northwest strike, thus cutting across the direction in which the main mass appeared to be running.

This mine has produced a large amount of good-sized mica. The color of the mica is clear "rum" and the quality excellent. The same may be said of the majority of the mines of this part of Cleveland County and Lincoln County adjoining. Quartz ledges are another feature common to many of the mines of this section. The difficulties encountered in working the Thompson Mine are found in nearly all the mines of this region, namely, large amounts of water to handle, formations that require much timbering, and the apparent pinching out of the mica-bearing rock in one or more directions.

Coward Mountain Mine.

The Coward Mountain Mine is near the top of the south end of Coward Mountain, on the north side of the Caney Fork Valley, Jackson County. The notable features are the occurrence of sheet-like horses of wall rock and streaks of quartz parallel to the walls of the pegmatite. The country rock is hard garnetiferous mica gneiss, somewhat schistose near the contact with the pegmatite. The latter is about 10 feet thick and strikes about N. 45° E., with a dip of 75° NW. Where seen near the surface, it is nearly or quite conformable

with the inclosing rock. Quartz is the predominant mineral and occurs in veins and streaks parallel to the wall rock. These streaks range from 1 or 2 inches up to a couple of feet in thickness. Feldspar is nowhere very abundant in the pegmatite and is confined chiefly to a streak 2 or 3 feet thick near the hanging wall, where with quartz and mica it forms the "vein." Horseshoes or sheets of schistose wall rock are included in the pegmatite in several places. They range from 2 or 3 to several inches in thickness. These horseshoes, together with the quartz bands and mica streak, all parallel to the walls, give a marked banded structure. Such inclusions of sheet-like horseshoes of wall rock and veins of quartz in parallel position are not uncommon in this region.

This mine has not been worked in recent years. The developments consist of a shaft on the "vein" reported to be 100 feet deep, with sufficient open-cut work at the surface to give working room on the mountain side. The mica is of a clear "rum" color, and, to judge from smaller pieces seen, of good quality. Some biotite is found with the clear mica. A little sulphide of iron is scattered through the "vein" and wall rock.

Cox & Davies Mine.

The Cox & Davies Mine is about three-fourths of a mile south of Cullowhee, Jackson County, on the point of a ridge, 200 or 300 feet above the road. The development consists of open cuts, shafts, and tunnels, mostly in bad repair. There are two parallel "veins" about 70 feet apart, and both have been worked for about 100 yards across the top of the ridge. The mica-gneiss country rock strikes about N. 80° E., with a southerly dip. The pegmatite masses conform with this in a general way, though they cut the gneiss in places.

A tunnel on the north "vein" was examined for about 150 feet into the hillside. The thickness of the "vein" was in the main from 2 to 4 feet, but in places it swelled to 6 or 8 feet. At one point the pegmatite was warped, the strike shifting from N. 70° E. to S. 80° E. and back again, with a varying southerly dip. It cut across the mica gneiss, which at this point had a strike of N. 45° E., and a vertical dip. Quartz was exposed only in smaller masses and ledges in this tunnel. The feldspar was partly kaolinized and easily removed in mining. Quartz was found to be more plentiful in the south "vein." In one of the tunnels still open a quartz streak nearly 2 feet thick was exposed in the roof and extended some distance back. Both

veins have been more or less "ground-hogged" through their whole length. This has been done mostly by petty leasers, who did not care what happened to the mine after their leases expired. Mica of excellent quality and in large quantity has been removed from each vein. The color is a fine, clear, light "rum" or "wine," and the mica is said to have brought always the highest prices.

Chink Knob Prospect.

South of Chink Knob, near the main road through Canada Township, Jackson County, is a small opening several feet deep, which is described here only because of the peculiar type of pegmatite exposed. The country rock is mostly mica gneiss, with smaller granitic masses included. These are doubtless outliers of the larger intrusions of granite in the neighborhood. Some of them assume a pegmatitic texture in places. The prospect reveals a vein of pegmatite from $3\frac{1}{2}$ to 4 feet wide. (See fig. 4.) It strikes about N. 5° W. and dips from 75° to 80° E., cutting one of the coarse granite masses already mentioned. The mica-gneiss country rock a few rods from the prospect had a strike of N. 55° E. and a dip of 50° NW.

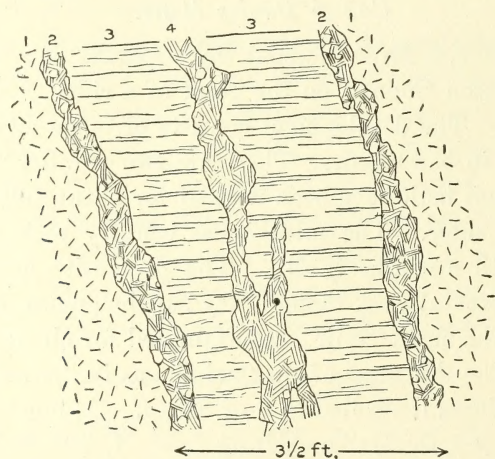


FIG. 4.—Section of pegmatite at mica prospect near Chink Knob, Jackson County, N. C. 1, Coarse granite; 2, mica and feldspar; 3, quartz, jointed; 4, feldspar with little mica.

The vein is composed largely of quartz. On each side and down through the interior of this quartz there is a streak or band of feldspar and mica. The interior band consists chiefly of feldspar with a small amount of mica, but in the bands between the walls and the quartz mica is probably in excess of the feldspar. The quartz is

massive and of a dark smoky color. It has a sheety columnar jointing about normal to its walls, probably caused by later rock movements. The mica is mostly wedge-shaped and "A." It is of a dark smoky color and partly "specked." Blocks from 3 to 5 inches across were probably the largest found during the prospecting.

Adams Mine.

The Adams Mine, $1\frac{1}{2}$ miles southeast of Webster, Jackson County, is unique. A small granite dike from $4\frac{1}{2}$ to 8 feet thick cuts sharply across the mica-gneiss country rock. The dike strikes N. 25° to 30° W. and dips from 55° to 70° NE.; the mica gneiss has about a northeasterly strike, with a dip varying from nearly vertical to 70° SE. This granite is rather fine grained and light grey to nearly white in color. It has an even texture and shows no banding. The dike has been traced over 100 yards along the strike by prospect cuts, pits and tunnels. On each side of the granite throughout its exposure there is a pegmatite streak from 1 to 2 feet thick. (See fig. 5.) In some places this pegmatite is made up

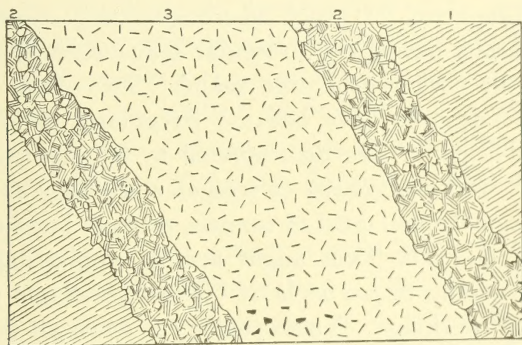


FIG. 5.—Section of pegmatite at Adams Mine, $1\frac{1}{2}$ miles southeast of Webster, Jackson County, N. C. 1, Wall rock (mica gneiss); 2, pegmatite, mostly mica; 3, granite, rather fine grained. Distance from wall to wall, 7 feet.

chiefly of mica; in others feldspar with some quartz is equally important. The contact between the pegmatite and granite is irregular and not sharp. Many of the mica crystals, especially those near the contact with the mica gneiss, have their cleavage planes normal to the walls of the pegmatite. They do not exhibit any other definite orientation, however. The feldspar has been kaolinized to some extent near the surface. The mica blocks are chiefly small (under 4 or 5 inches in diameter). They have a clear "rum" color, but many are

damaged by clay stains between the laminae. They are plentiful, however, and yield much punch and scrap material.

A pretty example of faulting is exposed in this mine. The mica streak on the southwest side of the granite has been brought nearly opposite that on the northeast side by a fault with an 8-foot throw. This fault strikes a little east of north and is nearly vertical. The formations on the east side of it have slipped to the north a few feet, or *vice versa*.

MINING AND TREATMENT OF MICA.

The methods employed in working most of the mines are simple. Open cuts are started on the outcrop, followed by shafts or tunnels when the "vein" is found sufficiently rich. In some of the larger mines power drills and steam pumps are employed and development proceeds rapidly. As a rule, however, simple tools are used, such as pick and shovel in decomposed formations and hand drills where hard rock is encountered. Dynamite is used chiefly in breaking down hard rock. The "vein" is worked out by shafts (generally inclined), tunnels, drifts, winzes, and stopes. The minimum of timbering is used, and pillars are left only where absolutely necessary. The workings generally have a very irregular shape, since they follow the mica streaks or pockets wherever found. Too often, in the past especially, the deposits have been so irregularly worked that the term "ground-hogging" has been applied to the methods employed. "Ground-hog" workings consist of irregular openings at the surface, shallow shafts, and small crooked tunnels, scarcely large enough for a man to work in. The term might also be appropriately used to describe the irregular stopes made by "jayhawkers" and petty leasers in underground workings. These people cut down all the mica-bearing material available and leave the waste to accumulate in the mine until further work is difficult or impossible.

Some of the mines are located in rather inaccessible places, to which tools and provisions have to be packed on men's shoulders, and from which the mica is brought away by the same methods. As the needs of the mountaineer and the variety of tools required are small, even these mines can often be operated at a profit.

At most of the mines blacksmith forges of suitable size to meet the requirement are set up, so that drills and tools can be sharpened and other shop work done. Each mine generally has a storage bin or house where the mica is kept and sorted over before selling or hauling

to trimming establishments. At some mines the output is sold in the rough. At others it is split and sized either with or without trimming off the rough corners and edges. Part of the production is shipped to the manufacturers after rough trimming and sizing, and the remainder is prepared for the market in local establishments by cutting into patterns and punching. The waste from the mines and scrap from the cutting houses is ground in local mills or shipped to mills outside of the State.

ORIGIN.

Mica of commercial size in North Carolina occurs only in pegmatite. It is uncertain whether this rock should be classed with dikes or veins. It is probable that some bodies are true dikes, whereas others may be vein formations. A large number falls into an intermediate class, of which it is not likely that a reference to either origin can ever be made. There seems to be no reason against accepting an intrusive origin for the majority of those pegmatites which have a typical granite texture and in which none of the constituent minerals is separated out in sheetlike masses parallel to the walls, especially those that are more persistent in extent in regions where granite intrusions are of large size or plentiful. On the other hand, it does not seem reasonable to consider certain forms of pegmatite, occurring in the region studied, as true igneous injections. In this statement are included such pegmatites as are illustrated in figs. 4 and 5, and probably also in fig. 3. In each of these masses banding is evident.

Fig. 4 represents a vein cutting a mass of coarse granite or pegmatite in a region of granite intrusions. The vein is composed of the same minerals, coarsely crystallized, as in pegmatite, and is itself pegmatite. It is evident that there have been several stages in its formation. Apparently the mica-feldspar bands along the walls were first formed, followed by the quartz, and then in the middle by the streak composed chiefly of feldspar. It is possible that the feldspar formed in a fissure in a once solid mass of quartz; though it probably occupies the portion of the original fissure that was never quite closed by the quartz. Fig. 5 represents an occurrence that is uncommon, though it possesses certain features bearing on the origin of pegmatite. The history shown by this deposit may be briefly described as follows: After movements associated with mountain building had

ceased—that is, in Carboniferous time or later—the granite dike was forced into a fissure or line of weakness cutting across the foliation of the country rock. Cooling was fairly rapid, and the texture was consequently rather fine. This was followed by the deposition of pegmatite from solutions passing along each side of the dike. A source for such solutions could be found in the final stages of activity of the magma from which the granite was formed.

These two illustrations are given to show that the formation of certain pegmatites is much more readily explained by referring it to aqueous agencies than to intrusion as an igneous body. With the probability thus established of an aqueous origin for certain pegmatites and an intrusive origin for others, we are confronted by a large number, the nature of whose origin is difficult to decide. Among these are many pegmatites like that represented in fig. 3, in which there is a banding consisting of a streak of feldspar with a little quartz mixed through it lying on each side of a quartz band. Locally, there are several quartz bands in the pegmatite. It is the opinion of the writer that such pegmatites are in part, if not wholly, of vein origin. The feldspar component, in many places containing more or less quartz mixed through it, may have been intruded as a magma and the whole modified by the secondary introduction of quartz by solution. It seems more likely, however, that if a part is to be considered the result of aqueous agencies the whole pegmatite should be so considered. A strong argument in favor of the deposition of these quartz bands from solution is afforded by the peculiar banding, apparently not due to strain, observed in the quartz streak at the Lyle Cut Mine. (See page 94.)

The blending between the conditions of fusion and solution conceived to exist under heat and pressure, such as prevail in deeply buried granite magmas where water is present in considerable quantity, has been well set forth by Van Hise,* Crosby and Fuller,† and Williams.‡ As stated by Van Hise, given the two conditions, a magma and a solution, with no sharp line of demarcation between them, we may expect to have injections of dikes and aqueous cementation, which grade into each other and between which no sharp distinction can be drawn. Van Hise further cites the occurrence of

* Van Hise, C. R., *A Treatise on Metamorphism*: Mon. U. S. Geol. Survey, vol. 47, 1904.

† Crosby, W. O., and Fuller, M. L., *Origin of Pegmatite*: Am. Geologist, vol. 19, 1897.

‡ Williams, G. H., *General Relations of the Granitic Rocks in the Middle Atlantic Piedmont Plateau*: Fifteenth Ann. Rept. U. S. Geol. Survey, 1895.

pegmatite in metamorphic rocks in the Marquette district of the Lake Superior region, where no parent granite mass was found, and concludes that the pegmatite was formed by the metamorphism of the rocks through mechanical action aided by aqueous agencies.

It is thought that these views are applicable to the pegmatites of North Carolina. Some are so clearly associated with large granite intrusions and are so like granite in their behavior toward the country rock that the theory of intrusive origin seems particularly appropriate. Others also in regions of granite masses exhibit structures so similar to those generally attributed to vein formations that they must be considered of aqueous origin. Still others show structures common to both igneous masses and vein formations and must be placed in the intermediate stage set forth by Van Hise. There are pegmatites within the areas of the Carolina and Roan gneisses which are so far removed from any known granite masses that it seems probable that they were produced during the metamorphism of the inclosing rocks, like those of the Marquette district. This theory is more plausible when the great extent of the regional metamorphism of the Carolina and Roan gneiss formations and the large number of small pegmatite streaks cutting them at all angles are taken into consideration.

The occurrence of drusy cavities, comb structure, and regular banding, such as is common in many fissure-vein deposits, is observed in few places, if anywhere, in the mica-bearing pegmatites of North Carolina. This is not to be wondered at when the conditions of the formation of pegmatite are considered. The materials are probably derived from deep-seated magmatic or metamorphic sources, and the pegmatite was formed at great depth under conditions of heat and pressure. If the material was itself a magma, the resulting form would be a dike, in which formation cavities are never looked for, except near the surface. If the material was a solution, either of magmatic or metamorphic origin, a vein would be produced. That veins do not necessarily have banded structure nor drusy cavities is plainly shown by many of the auriferous quartz veins of the southern Appalachians, in which genuine banding or crustification is rare and the majority show no trace of either. These veins are the mere stumps of a once extensive vein system that has been eroded away along with several thousand feet of the formations in which they oc-

curred. According to Graton,* these veins were formed by heated solutions forced, under great pressure, into what in many cases may have been the merest fractures and depositing their loads. The force of crystallization may also have aided in expanding the opening, but the principal force is supposed to be due to the pressure exerted by the weight of overlying formations on these solutions at a lower depth than that at which the vein was formed. It is thought that pegmatite veins may have formed in very much the same way as these auriferous quartz veins. Under similar conditions heated solutions, carrying the constituents of pegmatite instead of those of gold-bearing quartz veins, would form regular veins of pegmatite. Any irregularities in the composition of the solutions would produce the banding already described as of common occurrence in pegmatites.

It is difficult to conceive of the formation by injection, as an ordinary magma, of pegmatite in streaks or bands a fraction of an inch thick in gneissic rocks, in many places having no visible connection with other pegmatite bodies. On the other hand, it is easy to conceive of a solution being forced through the smallest fractures or working its way between the mineral particles and depositing its load. The latter process would not require such high temperatures, either in the solution or country rock, as would be required for the injection of a magma in order that it might not be cooled so quickly as to prevent coarse crystallization. The possibility of the formation of these smaller pegmatites by the injection of a highly fluid aqueo-igneous magma is not denied, especially if the magma approaches closely the conditions of a solution. It is thought, however, that aqueous processes afford a simpler and, therefore, more reasonable explanation.

Pegmatization of rock masses, so common in the Carolina gneiss, especially in the Piedmont Plateau region, has probably resulted from one or both of two causes—namely, either recrystallization due to aqueous agencies or the addition of more material from solutions passing through the formations. In the first process occluded water in the rock, aided by the heat generated during regional metamorphism, may have caused recrystallization and consequent pegmatitic texture. In the second process it is probable that pegmatization has resulted from solutions which were forced through the rock along cracks, seams, or bedding planes and there deposited their load. Where pegmatization is characterized by much feldspar, it is probable

*Graton, L. C., Gold and Tin Deposits of the Southern Appalachians: Bull. U. S. Geol. Survey No. 293, 1906, p. 60.

that these solutions were of magmatic origin, and one generally does not have to look far to find a granite intrusion in the neighborhood.

It is thought that pegmatites occurring in irregular masses, streaks, lenses, augen, or balls, and having no visible connection with other pegmatite bodies, are generally the result of aqueous action. A solution could be readily forced through fractures or seams along the bedding planes and deposit its load only in the more favorable places. If such bodies were formed by intrusions, it would be necessary to consider that the walls of the dike had been forced together, closing the passage through which the magma had passed. Though the possibility of such conditions is not denied, a simpler method of formation, as deposition from solution, is considered more probable. In augen and ball-shaped bodies of pegmatite without visible connection with other pegmatite masses, room for the segregation was probably produced by the expansive force of the growing feldspar crystals, which have crowded the gneiss or schist out on each side.

SUMMARY OF CONCLUSIONS.

It is uncertain whether pegmatites should be called intrusions or vein formations. It is probable that some are dikes and others are veins. Those with a typical coarse granite texture are probably of intrusive origin; those with a banded structure are probably the result of aqueous deposition. In view of certain examples, already illustrated by figures, these statements become more acceptable. Van Hise's conception of the condition of pegmatite material before the pegmatite was formed seems particularly applicable in this region; that is, given a magma and a solution with no sharp line of demarcation between them, there may be intrusions and aqueous cementation, also grading into each other. Graton's interpretation of the formation of the auriferous quartz veins of the southern Appalachians also seems particularly appropriate in accounting for pegmatite veins—that is, the solutions were forced into fractures or fissures under great pressure, and, by the aid of the expansion produced by the crystallization of the minerals being deposited, spread the walls apart sufficiently to allow the formation of the veins. The occurrence of much pegmatite in small streaks through the rock formations is probably caused either by recrystallization through the combined action of water and heat or by solutions being forced through fractures or seams and depositing their loads, or by both. It might also

be possible for such pegmatization to be produced by the injection of an extremely fluid aqueo-igneous magma into and through the formations. Disconnected bodies of pegmatite are also more readily explained by deposition from solution than by intrusion as dikes.

The question of the origin of pegmatites is chiefly of scientific interest rather than of commercial importance, for good deposits of mica are found in rocks of both dike and vein types. The quality of the mica from one type is, in general, no better than that from the other. It is probable, however, that those pegmatites which are typically of intrusive origin will be found to hold out longer than those with vein-like structure. Although the available evidence is insufficient to prove this definitely, there are certain dike-like masses that have been followed long distances, or to considerable depth, and found to carry paying mica to the limits worked. On the other hand, many vein-like deposits have been opened and large quantities of mica recovered from certain portions, and then the "vein" has abruptly become poorer or pinched out. Of course, there are vein-like deposits which have been worked through considerable distances, though probably none has held out so persistently as the bodies of intrusive origin.

PRODUCTION.

During 1906 the production of plate or cut mica was 800,440 pounds, valued at \$205,756, as compared with 1,044,800 pounds, valued at \$100,900, in 1905. This is an increase of \$104,856 in value, but a decrease of 244,360 pounds in quantity, and is due to the larger amount of mica produced in 1906 being the larger sheets. In 1905 there was an exceptionally large amount of smaller disks and rectangular sheets produced, such as are used for electrical purposes. The scrap mica produced in 1906 amounted to 1,129 tons, valued at \$11,940, an average of \$10 per ton. As compared with the production of 1905, of 275 tons, valued at \$3,375, this is an increase of 854 tons in quantity and of \$8,565 in value.

Although there is a large amount of mica imported into the United States each year, amounting in 1906 to a value of \$403,756, there is still a strong demand for the North Carolina mica, especially for those uses where the best quality of mica is desired. In the following table there are given the approximate value and distribution of the production of sheet mica by counties for the years 1902 to 1906, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA DURING 1902-1906, BY COUNTIES.

County.	1902.	1903.	1904.	1905.	1906.*
Ashe-----	\$-----	\$ 1,000	\$-----	\$-----	\$ 4,000
Buncombe-----	250	300	-----	-----	-----
Caldwell-----	-----	-----	10,000	-----	-----
Haywood-----	20,000	18,000	34,500	33,710	15,975
Jackson-----	5,700	5,500	924	7,900	20,899
Lincoln-----	-----	-----	-----	-----	210
McDowell-----	600	1,000	-----	-----	-----
Macon-----	4,000	3,500	-----	1,500	47,866
Madison-----	-----	-----	-----	90	-----
Mitchell-----	28,203	29,000	21,500	17,950	51,540
Stokes-----	1,000	7,500	-----	-----	731
Transylvania-----	750	500	-----	600	11,275
Watauga-----	-----	-----	-----	350	916
Yancey-----	21,150	20,000	34,000	38,800	64,284
Total-----	81,653	86,300	100,724	100,900	217,696

* In 1906 the values by counties include the value of both sheet and scrap mica.

The next table gives the value of the total production of mica, including both sheet and scrap, for the years 1900 to 1906, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA,
1900-1906.

Year.	Sheet Value.	Scrap Value.	Total Value.
1900-----	\$ 65,200	\$ 36,262	\$101,462
1901-----	79,849	14,200	94,049
1902-----	81,653	2,219	83,872
1903-----	86,300	2,400	88,700
1904-----	100,724	3,410	104,134
1905-----	100,900	3,375	104,275
1906-----	205,756	11,940	217,696

QUARTZ (FLINT).

PRODUCTION.

The total production of quartz, or flint, during 1906 was 20,963 tons, valued at \$12,578, as compared with 32,648 tons, valued at \$13,659, a decrease of 11,685 tons in quantity and of \$1,081 in value. This quartz is vein quartz and has been used as flux in copper smelting and for packing purposes. Besides this, there is a large amount of quartz that is used in the manufacture of brick, and for clay prod-

ucts and for foundry purposes. This is treated under the head of "Sand and Gravel." In the following table the production of quartz in North Carolina for the years 1901 to 1906, inclusive, is given:

PRODUCTION OF QUARTZ IN NORTH
CAROLINA, 1901-1906.

Year.	Quantity.	Value.
	<i>Tons.</i>	
1901 -----	3,000	\$ 7,500
1902 -----	4,500	11,250
1903 -----	29,462	36,827
1904 -----	32,972	36,269
1905 -----	32,648	13,659
1906 -----	20,963	12,578

BARYTES.

During 1906 the production of crude barytes in North Carolina amounted to 3,340 tons, valued at \$10,020. This is a decrease of 2,204 tons in quantity and of \$11,650 in value, as compared with 5,544 tons, valued at \$21,670, the production of 1905. This production was obtained from Madison County. For a number of years there has been a small production from Gaston County, but it did not report any in 1906. The uses and occurrence of barytes were described in some detail in Economic Paper No. 9.

In the following table there is given the production of barytes in North Carolina for the years 1901 to 1906, inclusive:

PRODUCTION OF CRUDE BARYTES IN
NORTH CAROLINA, 1901-1906.

Year.	Quantity, Short Tons.	Value.
1901 -----	6,890	\$20,865
1902 -----	14,679	44,130
1903 -----	6,835	21,347
1904 -----	13,413	33,930
1905 -----	5,545	21,670
1906 -----	3,340	10,020

MONAZITE.

There continues to be a large demand for Carolina monazite, and constant inquiries are received at the Survey Office for information regarding this mineral. The general conditions of this industry have been investigated by Mr. Douglas B. Sterrett* for the United States Geological Survey, and the results are given as part of this report.

* U. S. Geol. Survey, Advance Chapter of Mineral Resources for 1906.

LOCATION AND OCCURRENCE.

The area in which workable deposits of monazite have been found in the Carolinas is growing yearly, especially to the southwest in South Carolina, where parts of Laurens, Pickens, Anderson and Oconee counties are now included. This extends the belt in which deposits of commercial value are known to exist nearly to the Georgia line. To the northeast the belt has been extended beyond the limit set for it in southern Caldwell and northern Catawba counties into northern Iredell County and Alexander County, and will doubtless be traced farther. This area contains upward of 3,000 square miles, and includes parts or all of Iredell, Alexander, Caldwell, Catawba, Burke, McDowell, Gaston, Lincoln, Cleveland, Rutherford and Polk counties in North Carolina, and Cherokee, Laurens, Spartanburg, Greenville, Pickens, Anderson and Oconee counties in South Carolina. Monazite has been found at other places, outside of this area, but as yet no workable deposits have been developed.

A prospect in the extreme northeast corner of Georgia, in Rabun County, is being investigated at the present time for its values in monazite and gold. Through the courtesy of the party interested in the property the writer has learned that the concentrates assay over $5\frac{1}{2}$ ounces of gold per ton, with 30 per cent. of cerium oxide and 4 per cent. of thorium oxide. Since such a high content of cerium would correspond to nearly pure monazite, carrying no other minerals such as are generally found in concentrates, the oxide of lanthanum and didymium were probably included in that report for cerium. In that case the concentrates would run a little over 40 per cent. monazite if the rare earth oxides found by assay all came from monazite. If the percentage of concentrates that can be washed from the gravel is large, such a deposit is very promising.

Among other places, monazite is reported to occur in some quantity at a few localities in Clay County and near Mars Hill, Madison County. In the latter county monazite crystals $\frac{1}{2}$ inch thick and 1 inch long have been found. At Wilkesboro, N. C., a small quantity of monazite was found in a trial panning in Cub Creek. The area of known commercial deposits of monazite will doubtless be extended both to the northeast and to the southwest as the demands for monazite increase and the old deposits become exhausted.

The greater part of the monazite belt lies in the Piedmont Plateau.

The belt crosses the South Mountains, however, in Burke, McDowell and Rutherford counties, and borders on the foothills of the Blue Ridge. In the monazite region the elevations of the Piedmont Plateau vary from 700 or 800 feet to 1,500 feet above sea-level. Much of this area is dissected by river and creek valleys from 50 to 300 or 400 feet deep.

Workable deposits of monazite do not occur everywhere in the monazite belt as described, but are confined to certain smaller belts, whose direction and extent are controlled by the trend and continuity of certain rock formations from which are derived the deposits, found chiefly in the gravels and sands of creek and stream beds and adjoining bottom lands. Gravel deposits may be too low grade to work on the upper part of a stream, while lower down, where the area drained contains favorable rock formations, the gravels may be rich. Hence, for successful prospecting a general knowledge of the geological formations and ability to recognize those from which the monazite of the placers is derived is desirable.

GEOLOGY.

Classes of rocks.—Practically all of the rocks of the monazite region are either gneisses or schists.* The most important formation includes both of these types and is called Carolina gneiss. Other rock formations are gneissoid and porphyritic granite, hornblende gneiss and diorite, pegmatite, peridotite and allied rocks, and diabase.

The Carolina gneiss is by far the most extensive formation in the monazite region and appears in nearly every section. The granite-gneiss rocks are next in importance and occur in belts and irregular-shaped masses throughout the area of the Carolina gneiss. These granite masses vary from small dikes measured in feet or inches in thickness to large bodies 3 or 4 miles across. After the granites come the hornblende gneisses, which are most prominent along the northwest side of the region, where they are generally associated with large granite masses. Hornblende gneisses occur in other portions of the monazite belt, but are not of so much importance. The Carolina gneiss presents considerable variations in composition and structure. The most common types are mica, garnet, cyanite, and graphite gneisses and schists, or combinations of two or more of these types.

* Complete descriptions fitting many of these types of rocks may be found in the geologic folios published by the U. S. Geological Survey; see Geologic Atlas U. S., folio 116 [Asheville], folio 124 [Mount Mitchell], by Arthur Keith.

These rocks vary from light grey to dark grey in color and often have a light bluish-grey to bluish-black cast when graphite is abundant in them. Some of the schists are fine grained and are often composed of several distinguishing minerals, as muscovite, biotite, cyanite in fine needles, and graphite, besides fine grains of quartz and other minerals; others are composed of the same minerals in coarser grains or flakes. Garnets appear in each rock type and may be fairly large even in the finer-grained schist. The presence of much pegmatitic material is a characteristic feature of the Carolina gneiss.

The granite gneisses are either biotitic, muscovitic, or hornblende in composition, and in places have a typically porphyritic texture. In the latter case the feldspar phenocrysts generally assume an augen form, caused by crushing and elongation in the direction of shearing. There is an abundant development of small red garnets throughout many large areas of these granites. A microscopic section cut from a porphyritic granite forming the bed rock at the Moon Mine, 9 miles east of south of Greenville, S. C., contained the following minerals: Microcline, orthoclase, albite, quartz, biotite, muscovite, garnet, and a little zircon. The rock showed the effect of shearing, with the development or introduction of secondary minerals. The feldspar phenocrysts had been fractured and elongated, and secondary quartz had been deposited between the fragments. As a result of these metamorphic processes the feldspar crystals form augen-shaped bodies which lie parallel to the schistosity of the rock mass. The garnet is plainly secondary, and contains considerable quartz intergrown and included within it. In other parts of the region, as in the Carpenters Knob section and much of Cleveland County, there are large areas of granite gneiss which have an even granular texture and are composed chiefly of white feldspar, grey quartz, biotite, muscovite, and garnet.

The hornblende gneisses and diorites are the only other types of rock of much importance in the monazite region. The hornblende gneisses are nearly black to dark green in color, and are composed chiefly of small interwoven and matted hornblende crystals. They grade into diorite, which is also dark colored, but contain a noticeable amount of feldspar and have a granitoid texture. These hornblendic rocks are more prominent throughout the northwestern side of the monazite belt, where, along with large areas of granite, they assume considerable importance.

Pegmatite is of common occurrence throughout the region, especially in those areas where commercial deposits of monazite are found. There is a wide variation in the nature of this pegmatite. In some places it occurs as distinct masses or bodies with the typical composition and texture—that is, composed of quartz and feldspar, with or without mica and other accessory minerals, crystallized out on a large scale. In other places the pegmatite represents a recrystallization of portions of rock formations with the formation or introduction of the component minerals of pegmatite. Sometimes the secondary minerals consist chiefly of quartz with smaller quantities of the others. Often it is difficult to determine whether certain smaller rock masses are granite or pegmatite, when the texture is not very coarse and the relations to the inclosing rocks cannot be clearly seen in the small portions exposed.

The peridotites are not of very common occurrence in this region. They are dark green to greenish-black basic rocks, containing the ferromagnesian minerals olivine, pyroxene, and sometimes hornblende, as their chief constituents. The peridotites often outcrop prominently and generally leave rounded “nigger-head” boulders on the surface near their outcrop. In the majority of cases, however, the peridotites will be found to have partly altered to soapstone or serpentine at the surface. In some cases the whole mass has been thus metamorphosed.

Diabase is not uncommon in certain parts of the monazite region, and is readily recognized by its dark color, weight, and the characteristic spheroidal or “nigger-head” boulders it leaves scattered over the surface.

Age.—Most of the gneisses and schists of the monazite region are of great age and represent highly metamorphosed sedimentary and igneous rocks. The metamorphism, folding, and faulting of these rocks have been extreme, and in most cases it is difficult to determine the original nature of the formations, since much of the sedimentary bedding and igneous texture have been destroyed by smashing and recrystallization. This is especially true of the Carolina gneiss, which is the oldest formation represented and has been cut by intrusions of later age. The hornblende gneiss and diorite, the peridotite, and part, at least, of the granite-gneiss are also very old rocks and are intermingled and folded with the parts of the Carolina gneiss in a very complex way. Other gneisses and granites are of later age and have

not been subjected to the same degree of shearing as the older ones, so that the development of schistosity in them has not been so extensive as in the older types. The gneisses and schists, particularly of the Carolina gneiss, have been interbanded with and cut at all angles by numerous streaks of pegmatitic or granitic material. These streaks range from a fraction of an inch upward in thickness. In some places pegmatization is so thorough that mica gneiss has become strikingly like granite gneiss.

Associations of monazite.—The best deposits of monazite have been found in or near areas where large granite masses outcrop or where pegmatization of the country rock has been extreme. On the other hand, where the gneisses and schists are nearly free from pegmatitic material and there are no granite masses in the neighborhood, the stream gravels are found to be very poor in monazite. When monazite has been found in place to any extent in the country rock, it has not been in the ordinary pegmatite streaks and masses, but in portions of the rock formations where there has been extensive recrystallization, with the development or introduction of pegmatitic material. Such pegmatization is locally a common feature of the Carolina gneiss, which is accordingly a favorable kind of rock for the occurrence of monazite.

Monazite deposits in regions where hornblende rocks are abundant generally contain a large percentage of black sands. In such cases it is often difficult to concentrate the monazite to a marketable grade. As an offset to this, however, especially in regions where granite is associated with the hornblendic rocks, gold is often found in the concentrates in more than sufficient quantity to pay the cost of separation, and in the same localities the concentrates generally carry also a quantity of zircon, sufficient in some cases to pay for the separation. This zircon is in the form of small clear crystals with a brilliant luster, which range in size up to 1 millimeter square and about 2 millimeters long. A fairly clean separation can be made by cleaning with an electromagnetic machine and careful washing. The quantity and the size of the zircon crystals found in the monazite concentrates are in general smaller in the deposits located in areas of Carolina gneiss than in the granitic and hornblendic rock; likewise the quantity of gold found in the deposits in areas of Carolina gneiss is smaller and rarely pays the cost of separation.

Weathering and soils.—The rocks of this region have undergone such extensive weathering that good outcrops are the exception, and a thick mantle of residual soil covers much of the country. The kind of rock underlying certain soils can be determined, unless decomposition has been too thorough, by studying the outcrops and the gradations from such exposures into the residual soil. Thus the nature of the soils furnishes a clue as to the probability of monazite being present in quantity in the gravel of the streams; and, conversely, the nature of the country rock that a stream drains can often be told and the probable occurrence of monazite be conjectured by examining the débris in the gravels of the bottom lands and of the stream bed.

The Carolina gneiss, on partial disintegration and decomposition, often forms a gravelly soil with a red clayey matrix. This is especially characteristic of the graphite-cyanite type, which is abundant in parts of the region. The pebbles are composed of small fragments of the original rock, often tufts of cyanite, impregnated with hematite or limonite, or small pieces of pure iron ore.

Garnets may or may not be present. On more complete decomposition a reddish clayey soil results, with no decided characteristics. Other types of the Carolina gneiss, in which mica is an important constituent, leave a micaceous soil which often assumes a purplish color. Granites, on partial disintegration and decomposition, yield light sandy soils. Often blocks of undisintegrated granite occur scattered through the soils, giving additional evidence of the nature of the underlying rocks. On more complete decomposition granite yields soils of a light to dark reddish color, depending on the quantity of ferromagnesian minerals in the original rock, as biotite or hornblende. The quartz grains of the granite remain as sand mixed through a clayey matrix. Where the Carolina gneiss and granite are intimately associated, or where pegmatization has been extensive in a body of Carolina gneiss, there results a sandy soil, characteristic of granite, containing scattered through it pebbles of iron ore, characteristic of the Carolina gneiss. The relative importance of the iron-ore pebbles decreases in the soils as the quantity of pegmatite or of granite in the rock formations increases. These features of the soils are especially marked on the broad, flat ridges characterizing much of the Piedmont Plateau. The hornblendic rocks yield a dark reddish-brown to chocolate-colored clayey soil which is very characteristic.

MINING AND CLEANING.

Wet concentration.—Nearly all of the monazite shipped from the Carolinas has been obtained from gravel deposits. These deposits lie in and along the stream and creek beds, where the monazite has collected after liberation from the decomposing gneisses and schists of the region. A part of the production for 1906, however, was obtained from a monazite-bearing gneissic rock by crushing and then separating on concentrating tables. The percentage of monazite contained in the ore treated in either type of deposit is small and probably does not often run over 1 per cent.

The usual method of working the gravel deposits has been by washing in sluice boxes, though in 1906 concentrating tables were employed at several places. The form of table most used is the Wilfley or one of similar type. It is set up at the mine as convenient as possible to the gravel deposit to be treated, and is operated by a gasoline or kerosene motor. The gravel is dumped into a shaking hopper through which water is continually passing. The sand is washed through the hopper and passes over the table, while the oversize is shoveled out. At one mine the gravels are raised by a mechanical elevator and the oversize is removed in a revolving screen, from which the sand is passed over a table. In the better class of machines a number-one product can be taken off in the first washing, and the middlings be passed over a second time along with new sands. In some cases, however, where only two grades are separated, concentrates and tailings, a considerable quantity of rough concentrates is first washed out and then carefully sent over the machine a second time. In this way the grade of the sand is raised and a very clean product is obtained.

The degree of concentration it is possible to attain by wet methods depends largely upon the composition of the gravels to be treated and the care used in treating them. Where black sands, such as magnetite, ilmenite, etc., and other minerals with a high specific gravity are abundant it is difficult to bring the concentrates up to 50 per cent. monazite, even with good concentrating tables, and the product from sluice boxes may run as low as 15 per cent. and under. In more favorable deposits, where the percentage of black sand is not large, a concentrate running 80 or even 90 per cent. can be obtained with concentrating tables, while in sluice-box washing the grade can be brought up to 70 or even 80 per cent. Where the monazite is separated from

the hard rock formations the grade has been brought up to 95 per cent. and over by the use of concentrating tables. Taking the monazite region as a whole, there are not many large gravel deposits which will yield concentrates of over 40 per cent. monazite in sluice-box concentration, and the average yield of crude monazite would probably not be far from 30 per cent. Should the use of concentrating tables increase, the grade of the crude monazite produced will be raised correspondingly.

Formerly the deposits of monazite-bearing gravels in the bottom lands along the creeks and streams were worked without any thought of the land being left in such a condition that farming could be resumed after mining had ceased. So the soils were washed away, and the gravels were piled up in irregular heaps and ridges. In this way the best farming lands were being ruined, and those farmers who had leased their monazite deposits found themselves possessors of nearly worthless land, with only the money received on the leases. This has been remedied in many cases by more systematic working of the gravel beds. The top soil is thrown on the side of the working pit opposite to that on which the deposit lies, and the underlying gravel is washed. When the next block of gravel is opened the soil is thrown off upon the gravel already washed in the adjoining pit. By spreading the gravel out somewhat evenly and placing the soil smoothly over it nearly the whole land is kept in condition for farming after the monazite has been removed.

It has been found that, when the stream gravels are washed for monazite and then left for a few months, especially in rainy weather, another crop, so to speak, of monazite can be obtained. This results from the washing in of monazite from the surface of the surrounding fields and hills, where it has been left by the decomposition of the original rock matrix. With this end in view, the lands draining into the streams should be plowed now and then, to give the surface waters a chance to wash the monazite into the stream beds. In many cases the farmers have preferred to wash the stream gravels themselves once or twice, or more times, a year. The usual cultivation of their farm land keeps a fresh supply of monazite stirred up in the fields, from which much of it is washed into the creeks.

Electrical cleaning.—A portion of the crude monazite is shipped to the manufacturers as it comes from the mines. The greater part, however, is cleaned by electrical machinery at local cleaning mills in

the monazite region. In this way the percentage of monazite in the sand is greatly increased and the freight charges on waste products are minimized. The different types of machinery in use are (1) the Wetherill electro-magnetic machine and its modifications, (2) a machine in which the minerals are deflected by electro magnets while falling, and (3) a static machine.

Of the Wetherill machines there are two specially designed, improved types operated in different parts of the region—one in North Carolina, the other in South Carolina. In these machines there are four magnetic fields, which lift the different varieties of sand from a main conveying belt passing through them. Smaller belts, between the main belt and the magnetic pole lifting the minerals, carry the sand attracted by the different magnets out of the magnetic field and drop it into proper receptacles. In this way magnetic iron is removed by the first field; titanite iron, garnet, and other minerals of similar magnetic intensity by the second; and coarse and fine monazite by the third and fourth fields, respectively. Quartz, rutile, zircon, gold, and other highly nonmagnetic minerals pass off as tailings. This type of machine readily cleans the sand to 90 per cent., and is able to raise it to 95 per cent. monazite by careful handling. In another type of Wetherill machine, of which several have been used in the monazite region, there is but one magnetic field, which generally removes magnetic and titanite iron and garnet, while the monazite is left with the quartz, zircon, and other highly nonmagnetic minerals. The cleaned product from this machine probably averages about 80 per cent., and does not often run over 85 per cent. monazite. When the field magnets are properly constructed it is possible to pass the sand through the machine a second time under a much higher magnetic intensity and to free the monazite of many of the other minerals left with it in the first cleaning.

In the second type of the electro-magnetic machine the sand is passed over a series of belts, and the separation is effected by the deflection in a magnetic field of the grains of mineral as they fall over the ends of the belts. The different minerals are drawn out of their ordinary course of fall by powerful magnetic fields and are carried off in different chutes. In this way a very clean separation of monazite is said to be effected.

In the electro-static machine all the minerals but monazite and garnet are lifted from the sands. This is accomplished by a cylinder

about 2 feet in diameter and 3 feet long, covered with sheets of vulcanite, slightly separated from one another, 8 by 12 inches square and three-eighths of an inch thick. The vulcanite is excited by rubbing with felt-covered cylinders revolving at a high rate of speed. The speed is regulated by cone pulleys, and is made greater when the atmosphere contains considerable moisture. The sand is heated by two gasoline lamps before exposure to the electrified cylinder. The latter is revolved slowly, and all the sand attracted to it is removed by brushes.

MONAZITE IN ORIGINAL MATRIX.

New company and plant.—A new company entered the Carolina monazite field during 1906. This was the British Monazite Company, representing the South Metropolitan Gas Light Company of London, which undertook to mine monazite to secure a source of supply that could be depended on at times when the selling price of thorium products becomes excessive, or the supply in the market is limited by monopolies. The new company located about 3 miles northeast of Shelby, Cleveland County, where it has opened the old Campbell Mine with improved machinery and methods. The proposition at this mine is different from that of any other mine being operated in the region, and consists in crushing a monazite-bearing rock and separating out the monazite with concentrating tables. For this purpose a frame-work mill, well designed for the placing of the machinery used in treating the ore, was built adjacent to the outcrop of the ore body. Through the courtesy of Mr. Hugh Stewart, manager for the company, the following outline of the operation is given:

From the quarry the ore rock is trammed to the mill and dumped on the feed floor, whence it receives the following treatment:

1. Crushed in Gates gyratory crushers to 1 inch.
2. Elevated to bin, whence it is discharged to rolls crushing to one-sixth inch diameter.
3. Product from the latter is discharged into sizing apparatus (sieves). Material of one-fourth inch diameter or under goes through sieve and is discharged into second elevator. Material over one-fourth inch goes over sieve and is discharged into second crushing rolls, where it is reduced to one-eighth inch and is also discharged to second elevator.
4. Second elevator sends ore into Huntington mills, fitted with 16-mesh screens, through which the ore is discharged.
5. Ore from the Huntington mills is collected in hoppers and fed to

1 Wilfley and 3 Overstrom tables. The seconds and thirds from the first Wilfley and middlings from the Overstroms are passed over a second Wilfley table for final concentration.

The product from the mill runs between 90 and 95 per cent. monazite. A higher grade product can be obtained by careful treatment, but is not necessary. The company works the stream gravels on its property with sluice boxes and treats the concentrates obtained on one of the Wilfley tables, bringing it up to nearly 90 per cent. monazite.

Ore deposit.—At the time of visit the ore rock was being mined from a shallow open quarry over 150 yards long in a northerly direction and from 8 to 25 yards wide. The cut varied from 5 to 20 feet in depth and was irregular in shape. The rock was generally removed through the full height of the working face and the ore material was cobbled out. This was not usually difficult, as the ore rock differed in appearance from the lean. The rock was somewhat jointed and, being partly weathered, was easily removed with the aid of dynamite. The ore was hauled in tram cars, drawn by horses or mules, from the quarry to the mill at the southeast corner of the cut.

Monazite was found in all the rock taken from the cut, though the material used for ore occurred in bands varying from a few inches to 3 or more feet in thickness, interbedded with lower grade material. In places two or more streaks were worked for ore at the same time. All rock carrying above 0.4 or 0.5 per cent. monazite was treated as ore; beds carrying a lower percentage were discarded. Mill tests made on some of the lean streaks showed only 0.3 per cent. monazite.

Geology.—The country rock is Carolina gneiss, which has been considerably altered along certain strata by pegmatization. The beds have been thrown into a series of gentle folds. The latter, as exposed in the quarry, were from 20 to 50 or more feet from axis to axis. The rock as a whole is a pegmatized graphitic biotite gneiss, in which certain beds have been more highly recrystallized or pegmatized than others. The beds carrying larger percentages of monazite are those with a typical augen structure. The latter is due to porphyritic feldspar crystals and small bodies of pegmatite, ranging from the size of a grain of wheat to that of a walnut, scattered through the gneiss. Beds where pegmatization has been small, or where nearly the whole rock has been replaced by pegmatite, do not carry as much monazite as those in an intermediate position.

Under the microscope sections cut from specimens from one of the ore streaks show quartz, feldspar, biotite, graphite, muscovite, monazite, limonite in films and stains, and a very little zircon. Though the feldspar has been partially kaolinized and was mostly lost during the grinding of the sections, it seems to be chiefly orthoclase and microcline; but a few small fragments of albite are left in one of the sections. The greater part of the quartz is plainly secondary. It occurs in bands or streaks of grain running with the schistosity of the rock. In some places the quartz has been deposited in the fractures or between grains of other mineral, while in other places it includes fragments of such minerals as biotite and graphite. Inclusions of gas cavities and some very fine acicular mineral, probably rutile, are not uncommon in the quartz. Biotite occurs in interwoven laths and crystals roughly parallel with the banding of the rock. The pleochroism of the biotite is light yellow-brown to dark greenish-brown. The graphite occurs as plates and laths, in general lying parallel to the banding of the rock, and exhibiting various relations to the associated minerals. In some cases it is interbanded with, and even interleaved with, biotite, while in others the plates are turned across the schistosity. Monazite occurs in contact with the various minerals of the sections, though it is more often included in or surrounded by grains of quartz and biotite.

The rock has been so thoroughly recrystallized that it is impossible to say just what the original minerals were. The quartz was evidently the last mineral to be added, and the biotite was probably the first to be formed during recrystallization. Much of the graphite was apparently contemporaneous with the biotite; the remainder was plainly formed later. It would be difficult to give the order of formation of the muscovite, feldspar, and monazite. They are intermediate between the biotite and the quartz, or in some cases probably contemporaneous with the latter.

BRAZILIAN MONAZITE.

The principal source of supply of monazite for the world's consumption has been Brazil. In the United States, however, the market for the monazite has not only practically been supplied by the home production, but during the last several years a considerable amount of high-grade sand has been exported. In return, however, there is a large importation of manufactured thorium nitrate each year.

The Brazilian deposits lie along the coasts of the States of Bahia and Espirito Santo. The monazite occurs in the sand banks and dunes on the beaches, where it has undergone partial concentration by the action of the tides and waves. Gravel deposits of commercial value have also been reported along the River Parahyba, where a plant has been erected to test their value. The exploitation of the Brazilian beach deposits was first undertaken by John Gordon, an American. In the early days of mining Gordon shipped monazite sand as ballast at a cost of less than \$15 per ton to Hamburg, Germany, where he realized large profits on it, since the lowest price at that time for sand carrying 5 per cent. of thoria was \$95 to \$120 per ton. Later he was forced to enter an agreement with the German combination of thorium manufacturers without being able to establish the intended monopoly of the exports of Brazilian monazite. In 1903 the Brazilian legislative assembly decided that the deposits of monazite sand along the coast belonged to the Federal Government and forbade their exploitation. Later bids were let for the privilege of working these sands, and the rights were finally secured by A. C. de Freytas Company, of Hamburg. This company guaranteed a royalty of 50 per cent. of the sales made and an annual production of 1,700 tons. The de Freytas Company soon went into partnership with Gordon, and together they made an agreement to sell their whole product to the German thorium syndicate. From the latter they were to receive, in addition to the selling price, a share of the profits from the sale of thorium nitrate. In this way the thorium syndicate has held a partial monopoly over the production of monazite from Brazil.

When it was found that other manufacturers of thorium products were able to obtain supplies elsewhere and that the whole output of Brazil could not be controlled, the German thorium syndicate decided to kill out all competition. Accordingly, in January, 1906, the price of thorium nitrate was reduced to nearly half of that prevailing at the time. The quantity of nitrate sold to each consumer was limited to his demands and was so placed as to conflict with the attempted sales of companies not in the thorium syndicate. In this way the acquisition by brokers of large quantities of low-priced thorium nitrate for speculative purposes was avoided. This cut in the price of nitrate has been injurious or fatal to several smaller manufacturers of thorium products who had supplies of high-priced material in

stock, though it has not seriously affected larger, well-established firms mining their own monazite. The effect on the production of monazite in the United States has been very small, and it is doubtful whether the total output was in reality less than in 1905. The production all came from North Carolina and South Carolina, and represents the output of five companies, with a few independent producers. Three of the smaller companies, once active in the region, have either been forced out of business or handled no sand during 1906.

As reported by Consul-General G. E. Anderson,* the exports of monazite in 1906 were 4,787 short tons, valued at \$480,843, as compared with 4,881 short tons, valued at \$485,184, in 1905.

The federal authorities of Brazil continue to charge about 50 per cent. on exports of monazite, and the quality of the sand obtained is not so good as formerly. Exporters state that they cannot ship their monazite to the United States, since the tariff of 6 cents per pound for 5 per cent. thorium constituent is prohibitory.

PRODUCTION.

The production of monazite in North Carolina during 1906 amounted to 697,275 pounds, valued at \$125,510, as compared with 894,368 pounds, valued at \$107,324, in 1905. This increase in value and decrease in quantity is due to the fact that the 1905 product, which was reported in the condition sold by the producer, represented both cleaned and partly cleaned sand, while the 1906 production represents the cleaned sand as it is shipped to the manufacturers of thorium compounds. This production was obtained from Cleveland, Rutherford, Burke, McDowell, Lincoln, Polk, Catawba and Iredell counties, given in the order of the importance of their productions.

During the past year the price of thorium nitrate was reduced nearly one-half by the German thorium combine. Although this material is manufactured principally from monazite, there was no decrease noted in the selling price of the cleaned monazite sand.

* Monazite Sand in Brazil: Mining World, June 1, 1907, p. 691.

In the following table there is given the production and value of monazite mined in North Carolina from 1893 to 1906, inclusive:

PRODUCTION OF MONAZITE IN NORTH
CAROLINA, 1893-1906.

Year.	Monazite.	
	Pounds.	Value.
1893 -----	130,000	\$ 7,600
1894 -----	546,855	36,193
1895 -----	1,573,000	137,150
1896 -----	30,000	1,500
1897 -----	44,000	1,980
1898 -----	250,776	13,542
1899 -----	350,000	20,000
1900 -----	908,000	48,805
1901 -----	748,736	59,262
1902 -----	802,000	64,160
1903 -----	773,000	58,694
1904 -----	685,999	79,438
1905 -----	894,368	107,324
1906 -----	697,275	125,510

PRICES.

The price of thorium nitrate has shown some remarkable variations during the last thirteen years, as appears in the following table:

Prices (per kilogram of 2.2046 pounds) of thorium nitrate, 1894-1906.

Early in 1894.....	\$ 476.00	October, 1896.....	\$ 21.42
January, 1895.....	214.00	October, 1899.....	7.14
July, 1895.....	119.00	Later, and in 1905.....	12.61
November, 1895.....	71.40	January, 1906.....	6.43
May, 1896.....	35.70		

The prices paid for crude monazite in the North Carolina mining regions varied from 11½ cents per pound for very low-grade concentrates with small thoria content to 15 or more cents for the better grades. The average price was nearly 8 cents per pound.

ZIRCON.

PRODUCTION.

The production of zircon, which was all obtained from Henderson County, North Carolina, amounted in 1906 to 1,100 pounds, valued at \$248, as compared with 8,000 pounds, valued at \$1,600, in 1905. This zircon occurs in pegmatite, and at the present time represents the only source of zircon in the United States. There occurs as a by-product in monazite mining a fine zircon which can be concentrated to a very clean product, which offers a promising source of supply of this mineral, and one which should be of considerable value

to the producer of monazite, as in his cleaning process he obtains the zircon in a rather pure condition.

There is given in the following table the production and value of zircon mined in North Carolina from 1902 to 1906, inclusive:

PRODUCTION OF ZIRCON IN NORTH
CAROLINA FROM 1902 TO 1906,
INCLUSIVE.

Year.	Pounds.	Value.
1902 -----	2,000	\$ 380
1903 -----	3,000	570
1904 -----	1,000	200
1905 -----	8,000	1,600
1906 -----	1,100	248

TALC AND SOAPSTONE.

PRODUCTION.

The total production of talc and soapstone during 1906 amounted to 4,184 tons, valued at \$66,979, and was obtained from Swain, Cherokee, Moore, Alleghany, Jackson and Ashe counties. Besides the above, there was a small amount of soapstone quarried, principally in Ashe County, which was used for chimneys, fireplaces, etc. As there is very little talc sold in the crude state, the value given for the production represents the manufactured products, and the production is classified as it is marketed, as ground, manufactured, rough, and for chimney purposes. In the table below there is given the condition in which the 1906 production was marketed, together with the productions for 1904 and 1905:

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA DURING
1904, 1905 AND 1906.

Condition in Which Marketed.	1904.		1905.		1906.	
	Quan- tity, Short Tons.	Value.	Quan- tity, Short Tons.	Value.	Quan- tity, Short Tons.	Value.
Ground talc for powders, etc. -----	3,163	\$ 32,217	3,529	\$ 39,007	2,094	\$ 19,925
Talc cut into pencils, gas tips, etc. -----	208	28,673	205	32,568	1,020	35,688
Talc sold crude -----	430	4,417	301	3,115	895	11,116
Soapstone cut into slabs for chimneys, etc. -----		175		250		250
Total -----	3,801	65,483	4,035	74,940	4,009	66,979

The next table shows the quantity and value of talc and soapstone produced in North Carolina from 1898 to 1906, inclusive:

PRODUCTION OF TALC AND SOAPSTONE IN NORTH CAROLINA,
1898 TO 1906, INCLUSIVE.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	<i>Short Tons.</i>			<i>Short Tons.</i>	
1898-----	1,695	\$ 27,320	1903-----	5,331	\$ 76,984
1899-----	1,817	31,880	1904-----	3,801	65,483
1900-----	4,522	75,308	1905-----	4,035	74,940
1901-----	5,819	77,974	1906-----	4,184	66,979
1902-----	5,239	88,962			

PRECIOUS STONES.

During the past year Bulletin No. 12, on "The History of the Gems Found in North Carolina," by George F. Kunz, has been published, which describes in considerable detail the various gem minerals found in North Carolina. The report is rather freely illustrated by colored and black-and-white plates, showing some of the famous gem crystals and minerals that have been found in the State. This report is for general distribution, and copy of same can be obtained by writing to the State Geologist, Chapel Hill, N. C., and enclosing ten cents for postage. In the North Carolina mineral exhibit at the Jamestown Exposition there is a very complete collection of the gems and gem minerals of the State, which have been loaned by the American Gem and Pearl Company, the State Museum and Joseph Hyde Pratt. These collections illustrate the occurrence of gem minerals and show the gem in the rough state and as a cut stone.

PRODUCTION.

During 1906 the total production of precious stones of all kinds in North Carolina was \$5,000, as compared with \$3,350, the value of the production of 1905. This is an increase of \$1,650; but a decrease of \$5,600, as compared with \$10,600, the value of the 1904 production. The precious stones mined consisted of blue and yellow beryl, emerald and emerald matrix, aquamarine, ruby, sapphire, rhodolite, garnet and quartz gems, as amethysts, crystal, smoky and rutilated. These were obtained from Mitchell, Macon, Yancey, Jackson, Alexander, Cleveland, Lincoln and Iredell counties, given in the order of the estimated value of their output. There are two companies now operating in North Carolina especially for gems—the American Gem and Pearl Company, mining various beryl gems in Mitchell

County and rhodolites in Macon County, and the United States Ruby Company, who are mining rubies in Macon County.

In the following table is given the production of precious stones in North Carolina since 1900:

PRODUCTION OF PRECIOUS STONES IN
NORTH CAROLINA SINCE 1900.

Year.	Value.
1900-----	\$ 12,020
1901-----	24,245
1902-----	5,300
1903-----	1,525
1904-----	10,600
1905-----	3,350
1906-----	5,000

MINERAL WATERS.

PRODUCTION.

The production of mineral waters in 1906 was a decrease from that of the previous years and amounted to 158,680 gallons valued at \$31,413 as compared with 201,000 gallons valued at \$38,755, the 1905 production. There were 13 springs that reported these sales, as follows:

All Healing Spring, Taylorsville, Alexander County.

Barium Rock Spring, Barium Springs, Iredell County.

Buckhorn Lithia Spring, Bullock, Granville County.

Cleveland Spring, Shelby, Cleveland County.

Connelly Spring, Connelly, Burke County.

Haywood White Sulphur Spring, Waynesville, Haywood County.

Jackson Spring, Jackson, Moore County.

Mida Spring, near Charlotte, Mecklenburg County.

Morris Spring, Morris Springs, Stokes County.

Panacea Springs, near Littleton, Halifax County.

Seven Springs, near Goldsboro, Wayne County.

Thompson Bromine-Arsenic Spring, Crumpler, Ashe County.

Vade Mecum Spring, Stokes County.

The mineral spring water industry is slowly increasing in value as the springs become better known, and it is confidently expected that certain of these springs will eventually become large shippers of mineral water and represent an industry of considerable value to the State. Many of them have hotels run in conjunction with them which are dependent for their success upon the quality of the spring waters.

In the following table there are given the quantity and value of mineral water shipped for the years 1901 to 1906, inclusive:

PRODUCTION OF MINERAL WATERS IN NORTH CAROLINA SINCE 1901.

Year.	Amount, Gallons.	Value.
1901 -----	375,700	\$ 42,167
1902 -----	104,400	18,795
1903 -----	83,100	13,085
1904 -----	145,800	21,902
1905 -----	201,000	38,755
1906 -----	158,680	31,413

GRAPHITE.

PRODUCTION.

The production of graphite in North Carolina is very small and for the past three years has been 100 tons, which was obtained from Wake County. In the following table there is given the production of graphite from 1901 to 1906, inclusive:

PRODUCTION OF GRAPHITE IN NORTH CAROLINA FROM 1901 TO 1906.

Year.	Quantity.	Value.
	<i>Tons.</i>	
1901 -----	95	\$ 559
1902 -----	830	4,300
1903 -----	50	243
1904 -----	100	525
1905 -----	100	475
1906 -----	100	475

COAL.

During the past year exploration work has been carried on in the Moore County coal field to the west of Cumnock Mine, which has been the only producer in this region for a great many years. The property exploited consists of a tract of land containing 625 acres with a frontage of one mile on Deep River, being bounded on its northwest side by Horseshoe Bend. It is 3 miles above Carbon-ton, N. C., and one mile from Haw Branch, a station on the Durham and Charlotte Railroad. This property is being developed by Mr. D. P. Bible, of Newport, N. C., who has run a cut 12 to 20 feet for a distance of 75 feet, starting at the base of a high hill. At the end of the cut a drift extends 20 feet following the dip of the vein, which is about 16°. A level has been run to the northwest for 30 feet

and has exposed an upper seam of coal 18 inches thick; then a seam of slate above 18 inches and then a 28-inch seam of coal. The seam of slate has been constantly diminishing. There have been about 200 tons of coal taken out thus far during the exploration of this property, but none has been sold or shipped.

PRODUCTION.

The production of coal in North Carolina has been growing constantly less for a number of years, and in 1906 there was none at all produced. In 1905 the production was only 1,557 tons valued at \$2,336. In the following table is shown the distribution of the coal product of North Carolina for the years 1901 to 1905:

DISTRIBUTION OF THE COAL PRODUCT OF NORTH CAROLINA, 1901-1905.

Year.	Loaded at Mines for Ship-ment.	Sold to Local Trade and Used by Employ-ees.	Used at Mines for Steam and Heat.	Total Quan-tity.	Total Value.	Average Price Per Ton.	Average Number of Days Active.	Average Number of Em-ployees.
	<i>Short Tons.</i>	<i>Short Tons.</i>	<i>Short Tons.</i>	<i>Short Tons.</i>				
1901-----	10,000		2,000	12,000	\$ 15,000	\$ 1.25	300	25
1902-----	20,400	100	2,500	23,000	34,500	1.50	285	40
1903-----	14,429	87	2,793	17,309	25,300	1.47	264	49
1904-----	4,600	300	2,100	7,000	10,500	1.50	240	25
1905-----	461	1,096		1,557	2,336	1.50	60	15

The next table shows the production of coal in North Carolina since 1890, when the Cumnock Mine was reopened:

COAL PRODUCTION IN NORTH CAROLINA FROM 1890 TO 1906.

Year.	Quantity.	Year.	Quantity.
1890-----	10,262	1899-----	26,896
1891-----	20,355	1900-----	17,734
1892-----	6,679	1901-----	12,000
1893-----	17,000	1902-----	23,000
1894-----	16,900	1903-----	17,309
1895-----	24,900	1904-----	7,000
1896-----	7,813	1905-----	1,557
1897-----	21,280	1906-----	0,000
1898-----	11,495		

STONE.

INTRODUCTION.

Building stones offer one of the most promising fields for investment of any in North Carolina and the value of these deposits is becoming better known every year. As they are brought to the at-

ention of architects and contractors, new orders for stone are received in as many new localities. Thus during the past ten years the value of the building stone production has increased from \$70,736 to \$854,301, which has been due to the advertising of the stone and bringing it to the attention of architects and builders.

In 1906 the total value of the production of all kinds of stone was \$854,301, which is an increase of \$256,379 as compared with \$597,922, the value of the production of 1905. There is given in the following table the value of the production of various stones for the years 1900 to 1906, inclusive:

PRODUCTION OF BUILDING STONES IN NORTH CAROLINA, 1900-1906.

Year.	Granite.	Sandstone.	Marble and Limestone.	Total Value.
	<i>Value.</i>	<i>Value.</i>	<i>Value.</i>	
1900.....	\$ 257,962	\$ 27,210	\$*-----	\$ 285,172
1901.....	264,906	11,682	8,357	284,945
1902.....	338,749	4,825	23,153	366,727
1903.....	334,357	600	25,365	360,322
1904.....	292,439	250	19,887	312,576
1905.....	564,425	4,482	29,015	597,922
1906.....	778,819	3,431	72,051	854,301

* Statistics not collected for 1900.

GRANITE.

PRODUCTION.

The year 1906 has seen a most gratifying advance made in the granite industry in North Carolina. Many new markets have been found for North Carolina granite, and in every case it has been most favorably received. During 1906 the total value of all the granite produced was \$778,819, which, compared with the value of the 1905 production, \$564,425, was an increase of \$214,394. The number of operators quarrying granite during 1906 was 25, an increase of 1 over the number quarrying during 1905, and these worked 30 different quarries in the following fourteen counties, given in the order of the importance of their productions: Rowan, Surry, Rockingham, Lenoir, Buncombe, Polk, Warren, Orange, McDowell, Vance, Henderson, Cabarrus, Gaston, Catawba and Davidson. Davie, one of the 1905 producers, drops out for 1906, while Rockingham reappears and Catawba and Davidson are added to the list.

Nearly half of the granite produced in the State during 1906 was used for building and ornamental purposes, the value being \$375,074. This is an increase of \$62,712 over the value of the 1905

product used for these purposes, which amounted to \$312,362. There was a very large increase in the value of the granite used for road-making, railroad ballast, etc., the value of the 1906 production being \$228,429 and of the 1905 production \$118,470, an increase of \$109,959.

There are given in the following table the value and uses of granite quarried from 1901 to 1906, inclusive:

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901-1906.

Uses.	1901.	1902.	1903.	1904.	1905.	1906.
Building and monumental purposes ----	\$108,574	\$167,639	\$127,486	\$ 75,632	\$312,362	\$ 375,074
Paving blocks -----	10,662	6,986	30,780	15,807	48,234	33,428
Curbing and flagging -----	56,245	82,615	68,099	101,632	74,307	138,090
Crushed stone for road-making, railroad ballast, etc. -----	89,425	77,759	102,524	93,296	118,470	228,429
Other purposes -----		3,750	5,468	6,072	11,052	3,798
Total value -----	264,906	338,749	334,357	292,439	564,425	778,819

There is given in the following table the value of the granite product from 1897 to 1906, inclusive. This shows very strikingly the marvellous growth of this industry:

PRODUCTION OF GRANITE IN NORTH CAROLINA, 1897 TO 1906.

Year.	Value.
1897 -----	\$ 59,236
1898 -----	79,969
1899 -----	225,544
1900 -----	257,962
1901 -----	264,906
1902 -----	338,749
1903 -----	334,357
1904 -----	292,439
1905 -----	564,425
1906 -----	778,819

SANDSTONE.

PRODUCTION.

The sandstone industry in North Carolina is but a very minute part of the stone industry. The production of this type of building stone has never been very large and in 1906 it only amounted in value to \$3,431, which is a decrease of \$1,051 as compared with the value (\$4,482) of the 1905 production. As in the previous year, nearly all of the production of 1906 was dressed stone used for building purposes. There is given in the following table the value of the production of sandstone for the years 1897 to 1906, inclusive, and it illustrates how small this industry is in the State:

PRODUCTION OF SANDSTONE IN NORTH
CAROLINA, 1897 TO 1906.

Year.	Value.
1897-----	\$ 11,500
1898-----	9,100
1899-----	10,300
1900-----	27,210
1901-----	11,682
1902-----	4,825
1903-----	600
1904-----	250
1905-----	4,482
1906-----	3,431

MARBLE AND OTHER FORMS OF LIMESTONE.

PRODUCTION.

When one considers the demand for lime in North Carolina and the small amount produced in the State, one readily realizes that there should be favorable opportunities for investment in lime kilns in this State. Their success, however, depends largely on favorable freight rates. Although there was an increase in the total amount of lime produced during the past year, yet this is but a very small proportion of the total amount that is used in the State. During 1906 the total amount of lime produced amounted to 147,410 bushels valued at \$41,468 and was obtained from Henderson, Buncombe, Transylvania and New Hanover counties. There was also quarried in New Hanover County 23,872 tons of limestone valued at \$30,588, which was used for road building. This makes a total value of the limestone produced in the State during 1906 of \$72,051. This is an increase of \$43,036 as compared with \$29,015, the value of the 1905 production. There was no marble produced in the State during 1906.

In the following table is given the value of the production of limestone from 1901 to 1906, inclusive:

PRODUCTION OF MARBLE AND OTHER
FORMS OF LIMESTONE, 1901-1906.

Year.	Value.
1901-----	\$ 8,357
1902-----	23,153
1903-----	25,365
1904-----	19,887
1905-----	29,015
1906-----	72,051

SAND AND GRAVEL.

The figures given under this head simply include the production of sand used by molders. Besides this there is an enormous quantity of sand and gravel produced each year and utilized in the manufacture of brick, railway, highway and sidewalk construction, for flux, etc. In the manufacture of mortar for bricklaying there was undoubtedly at least 225,000 tons of sand used in 1906. Then besides this amount there is an enormous amount used in the manufacture of plaster. The amount used as molding sand was 843 tons valued at \$491. This does not represent all the sand used for this purpose, for the reason that many foundrymen obtain what they desire close by their shops and keep no record of the quantity used. There was also reported a production of 23,750 tons valued at \$8,700, which was designated as building sand. This makes the total production of sand reported 24,593 tons, valued at \$9,191.

SAND-LIME BRICK.**PRODUCTION.**

The manufacture of sand-lime brick in North Carolina is an industry that was begun but a few years ago. It has, however, constantly been increasing its production, and in 1906 the total number of sand-lime brick produced was 3,897,000 brick valued at \$32,975, of which 3,147,000 were common brick valued at \$22,225 and 750,000 were front brick valued at \$10,750. This production was made by three producers in Buncombe, Scotland and New Hanover counties. In the following table there is given the production of sand-lime brick in North Carolina for the past three years:

PRODUCTION OF SAND-LIME BRICK IN NORTH CAROLINA, 1904-1906.

Year.	Common Brick.		Front Brick.		Total Value.
	Number.	Value.	Number.	Value.	
1904	1,800,000	\$ 17,500		\$	17,500
1905	3,185,000	20,953	660,000	8,150	29,103
1906	3,147,000	22,225	750,000	10,750	32,975

CLAY.

During the past few years there has been a constant increase in the production of clay products in North Carolina, and in 1906 there was a large increase in the value of the production of the clay

products, as compared with that of 1905. Notwithstanding this increase, the clay industry in North Carolina does not as yet begin to equal the production that the quantity and quality of the various clays throughout the State would warrant. They offer most promising fields for investment, this being especially true of the manufacture of pressed, fancy and vitrified brick, in the manufacture of earthenware and stoneware, in the manufacture of porcelain, electrical insulators, etc., and in the manufacture of tiling, sewer pipe and terra cotta. While there has been some advance made along some of these lines during the past year, and a number of new companies have been organized, yet by far the larger portion of the better qualities of clays is still shipped outside the State. The demand for the better quality of brick, for porcelain-ware and all kinds of terra cotta is very large in North Carolina, and there are large quantities of these products imported into the State each year, which in many instances could have been manufactured from clays known to exist in North Carolina.

In 1906 the total value of all clay products manufactured in North Carolina amounted to \$1,182,438. Including the value of kaolin, all of which was shipped out of the State, the total value of the clay industry in the State for 1906 was \$1,272,796. As compared with the value (\$1,124,052) of the 1905 production, this is an increase of \$148,744.

KAOLIN.

The production of kaolin in North Carolina in 1906 was obtained from Jackson, Swain, Mitchell and Richmond counties, given in the order of the importance of their productions. This amounted to 11,803 tons, valued at \$90,036, as compared with 10,988 tons, valued at \$85,622, in 1905, this being an increase of 815 tons in quantity and of \$3,414 in value. The average value of the 1906 production was \$7.63 per ton, which is a decrease of 16 cents, as compared with the average value of \$7.79 per ton of the 1905 production. As far as can be learned, all of this kaolin was used in the manufacture of pottery and paper.

POTTERY CLAY.

PRODUCTION.

There continues to be a decline in the pottery industry in North Carolina, and in 1906 the value of this production was only \$11,770, a decrease of \$1,549, as compared with \$13,319, the value of the

1905 production. This small production was divided amongst twenty-eight manufacturers in the following eight counties, given in the order of the importance of their productions: Catawba, Lincoln, Randolph, Buncombe, Wilkes, Union, Moore, Johnston. None of the twenty-eight manufacturers produced any great amount of pottery, the largest one only producing pottery to the value of \$1,500. Of this 1906 production, \$713 was the value of red earthenware, and \$11,057 was the value of the stoneware.

There was a small amount of pottery clay sold crude in 1906, amounting to 188 tons, valued at \$137. The values of the different grades of pottery produced in 1905 and 1906 are given by counties in the following table:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA BY COUNTIES IN 1905 AND 1906.

County.	1905.			1906.		
	Earthen-ware.	Stone-ware.	Total.	Earthen-ware.	Stone-ware.	Total.
Buncombe-----	\$ 125	\$ 2,725	\$ 2,850	\$ 100	\$ 1,325	\$ 1,425
Catawba-----		1,930	1,930	135	4,600	4,735
Chatham-----		500	500			
Johnston-----	100	150	250	50	40	90
Lincoln-----	20	2,059	2,079		1,757	1,757
Moore-----		100	100	50	100	150
Randolph-----		790	790	150	1,495	1,645
Union-----	100	2,400	2,500	178	740	918
Wilkes-----	42	2,278	2,320	30	1,000	1,030
Total-----	387	12,932	13,319	713	11,057	11,770

FIRE CLAY AND PIPE CLAY.

PRODUCTION.

The clays and clay products included under this head are fire and pipe clays, fire brick, sewer pipe, drain tile, fancy tile, flue linings, terra cotta, etc. The total value of all these products reported in 1906 was \$120,965. This is an increase of \$9,693 as compared with \$111,272, the value of the 1905 production. Although there has been a considerable advance made in the production of fire-clay and pipe-clay products since 1900, there are still many opportunities for investment along these lines. Of this 1906 production \$7,180 was the value of 401,000 fire brick, which were manufactured in Buncombe and Randolph counties. This is a decrease of 280,000 brick in quantity and of \$1,153 in value as compared with 681,000 brick valued at \$8,333, the production of 1905. There was also a small

amount of crude fire clay sold in 1906, amounting to 19 tons, valued at \$185. The production of terra cotta, sewer pipe, tile, drain tile, etc., during 1906 was valued at \$113,900, and was obtained from Guilford, Beaufort and Randolph counties, given in the order of the importance of their productions. This is an increase of \$11,455 in value as compared with \$102,445, the value of the 1905 production. In the following table the production of fire-clay and pipe-clay products for the past six years is given, and this shows a decided increase in the value of this industry during that time:

PRODUCTION OF FIRE-CLAY AND PIPE-CLAY PRODUCTS IN NORTH CAROLINA,
1901-1906.

Year.	Fire Brick.		Sewer Pipe, Tile, Etc.	Crude Clay.	
	Quantity.	Value.		Tons.	Value.
1901 -----	55,000	\$ 550	\$ 55,745	-----	\$ 100
1902 -----		1,203	72,618	-----	215
1903 -----	407,500	5,250	100,989	231	875
1904 -----	163,000	2,700	110,800	80	700
1905 -----	681,000	8,333	102,445	57	494
1906 -----	401,000	7,180	113,900	19	185

BRICK CLAY.

PRODUCTION.

As was stated in the report for 1905, there are in nearly every county of North Carolina clay deposits suitable for the manufacture of common brick, these consisting of both residual and sedimentary clays. In some instances the deposits are of such character that a common brick of the best quality can be made. Often the brick yards can be favorably located near railroad transportation and usually fuel for burning the brick can be obtained at a very low price. Notwithstanding these advantages for brick manufacture in the State, the industry has not been as valuable as it should have been, and it is largely due to the lack of capital for installing machinery and also for lack of men experienced in brick manufacture. The total number of brick manufactured in North Carolina during 1906, with the exception of fire brick, amounted to 167,123,000 valued at \$1,049,488. This is an increase of 12,238,000 brick in quantity and of \$135,674 in value as compared with 154,885,000 brick valued at \$913,814, the production of 1905. The average value per thousand of this 1906 production was \$6.28. As compared with \$5.89, the average value per thousand of the 1905 production, this is an in-

crease of 39 cents per thousand. This large increase in the production of brick in the State has been due to the large amount of construction work that has been done, and this demand is continuing through 1907.

There were 61 counties from which this production was obtained, this being two more than in 1905. Davie, Jackson, Macon, Martin and Onslow counties, which reported no production during 1905, were producers during 1906, while, on the other hand, Cabarrus, Stokes and Yadkin counties, which were producers in 1905, made no production in 1906. Of the 1906 production, 166,338,000 were common brick valued at \$1,041,078, which is an increase of 12,728,000 brick in quantity and of \$144,789 in value as compared with 153,610,000 common brick valued at \$896,289, the 1905 production. The number of pressed and fancy brick in 1906 was 385,000 valued at \$4,410, and of vitrified brick 400,000 valued at \$4,000.

There are given in the following table the quantity and value of common, pressed, vitrified and fire brick produced during the past four years:

PRODUCTION OF COMMON, PRESSED, VITRIFIED AND FIRE BRICK
IN 1903, 1904, 1905 and 1906.

Character.	1903.		1904.		1905.		1906.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Common brick----	136,822,900	\$731,802	143,988,850	\$795,494	153,610,000	\$896,289	166,338,000	\$1,041,078
Pressed brick----	766,000	8,230	1,510,000	17,375	875,000	13,925	385,000	4,410
Vitrified brick----	500,000	5,000	430,000	3,850	400,000	3,600	400,000	4,000
Fire brick-----	407,500	5,250	163,000	2,700	681,000	8,333	401,000	7,180
Total -----	138,496,400	750,282	146,091,850	819,419	155,566,000	922,147	167,524,000	1,056,668

There was some increase in the average value per thousand received for common brick in 1906 as compared with the average value per thousand received for the 1905 product. While this is due partly to a better quality of brick manufactured, it is due largely to the greater demand for common brick. The average value per thousand received for 1906 was \$6.25, which is 42 cents greater than the average value of 1905. The lowest value per thousand reported as having been received for common brick during 1906 was \$4, which was received for 50,000 brick in Forsyth County, for 400,000 in Harnett County, and for 2,000,000 in Union County. The highest value per thousand received for common brick was \$10 re-

ceived for 300,000 brick in Guilford County. The number of manufacturers engaged in making brick in 1906 was 20 more than the number (164) engaged in this business in 1905.

In the following tables the total number and value of the different varieties of brick manufactured in North Carolina are given for the years 1905 and 1906 by counties:

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING 1905,
BY COUNTIES.

County.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified and Fire Brick.	Value.
Alamance	4,275,000	\$ 27,950		\$		\$
Anson	250,000	1,500				
Beaufort	2,425,000	14,850				
Bertie	75,000	450				
Bladen	125,000	750				
Buncombe	4,340,000	26,833	55,000	725	481,000	5,683
Burke	1,240,000	6,250				
Cabarrus	8,200,000	53,200	500,000	10,000	500,000	6,250
Caldwell	3,300,000	16,500				
Catawba	3,200,000	14,750				
Chatham	300,000	1,500				
Chowan	1,100,000	7,700				
Cleveland	825,000	4,800				
Columbus	2,075,000	12,500				
Craven	8,764,000	48,765				
Cumberland	3,000,000	16,500				
Davidson	3,000,000	19,000				
Duplin	40,000	263				
Durham	9,475,000	57,063				
Edgecombe	4,975,000	29,950	120,000	1,200		
Forsyth	10,283,000	55,915				
Franklin	2,300,000	14,500				
Gaston	2,220,000	11,520				
Greene	810,000	5,420				
Guilford	8,133,000	47,799				
Halifax	4,850,000	26,950				
Harnett	100,000	700				
Haywood	550,000	3,025				
Henderson	1,000,000	5,000				
Iredell	1,200,000	7,200				
Johnston	3,515,000	22,240				
Lenoir	700,000	3,500				
Lincoln	20,000	120				
McDowell	300,000	1,800	200,000	2,000		
Madison	125,000	625				
Mecklenburg	5,000,000	27,500				
Moore	1,809,000	9,854				
Nash	1,500,000	9,000				
New Hanover	2,750,000	16,500				
Orange	550,000	2,750				
Pasquotank	2,400,000	13,600				
Pender	500,000	3,000				
Perquimans	190,000	1,330				
Pitt	1,100,000	6,950				
Randolph	2,396,000	13,183				
Robeson	2,345,000	16,888				
Rockingham	2,450,000	14,450				
Rowan	3,760,000	21,800				
Rutherford	435,000	2,556				
Scotland	300,000	1,800				
Stokes	1,000,000	7,000				
Surry	870,000	5,080				
Union	3,674,000	19,900				
Wake	4,808,000	28,559				
Washington	100,000	800				
Wayne	10,750,000	59,563				
Wilkes	1,500,000	9,000				
Wilson	6,166,000	37,000				
Yadkin	167,000	838				
Total	153,610,000	896,289	875,000	13,925	981,000	11,933

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING 1906,
BY COUNTIES.

County.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified and Fire Brick.	Value.
Alamance	3,858,000	\$ 25,650		\$		\$-
Anson	500,000	3,000				
Beaufort	2,783,000	16,700				
Bertie	21,000	147				
Bladen	350,000	2,450				
Buncombe	5,271,000	35,350	100,000	1,500	388,000	6,980
Burke	1,710,000	8,551				
Caldwell	1,200,000	7,200				
Catawba	3,800,000	23,500				
Chatham	300,000	1,500				
Chowan	1,000,000	7,500				
Cleveland	1,249,000	7,711				
Columbus	2,250,000	14,000				
Craven	1,900,000	11,400				
Cumberland	4,700,000	27,750				
Davidson	2,900,000	18,000				
Davie	225,000	1,238				
Duplin	325,000	5,622				
Durham	7,450,000	49,850	60,000	660		
Edgecombe	7,230,000	44,800				
Forsyth	14,077,000	80,796	200,000	2,000		
Franklin	1,000,000	7,000				
Gaston	6,535,000	43,348				
Greene	700,000	4,700				
Guilford	8,550,000	54,605				
Halifax	5,650,000	33,800				
Harnett	500,000	3,900				
Haywood	300,000	2,400				
Henderson	2,000,000	11,000	25,000	250	*400,000	4,000
Iredell	3,350,000	21,100				
Jackson	16,000	100				
Johnston	3,500,000	23,400				
Lenoir	9,000,000	55,850				
Lincoln	800,000	5,600				
McDowell	333,000	2,000				
Macon	150,000	750				
Madison	200,000	900				
Martin	20,000	100				
Mecklenburg	5,650,000	37,500				
Moore	1,700,000	11,500				
Nash	1,950,000	13,750				
New Hanover	3,500,000	21,000				
Onslow	150,000	1,010				
Orange	550,000	3,175				
Pasquotank	2,100,000	13,650				
Pender	600,000	3,600				
Perquimans	300,000	2,100				
Pitt	1,488,000	9,909				
Randolph	1,717,000	10,452				
Robeson	3,052,000	21,759				
Rockingham	1,950,000	12,750				
Rowan	3,550,000	24,300				
Rutherford	675,000	4,187				
Scotland	200,000	1,200				
Surry	6,700,000	39,000				
Union	3,057,000	18,288				
Wake	4,397,000	26,342				
Washington	183,000	1,100				
Wayne	10,720,000	63,413				
Wilkes	700,000	3,700				
Wilson	5,250,000	34,125				
Total	166,338,000	1,041,078	385,000	4,410	801,000	11,280

*Vitrified brick.

Only 61 counties out of 97 made any production of brick, and of these Forsyth County produced the largest number of brick in 1906, amounting to 14,277,000 brick valued at \$82,796. Wayne County

was second with a production of 9,720,000 brick valued at \$63,413, and Lenoir County was third with a production of 9,000,000 brick valued at \$55,850. In 1905 the first three counties were Wayne, Forsyth and Cabarrus, with the following productions respectively: 10,750,000 brick valued at \$59,563; 10,283,000 brick valued at \$55,915; 9,200,000 brick valued at \$69,450. The county producing the smallest number of brick was Jackson, with a production of 16,000 brick valued at \$100.

In the tables below are given the quantity and value of all the clay products produced in North Carolina from 1901 to 1906, inclusive:

VALUE OF CLAY PRODUCTIONS OF NORTH CAROLINA IN
1901, 1902, 1903, 1904, 1905 AND 1906.

	1901.		1902.		1903.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Common brick-----	134,441,570	\$697,861	131,611,700	\$694,827	136,822,900	\$ 731,802
Pressed brick-----	1,095,000	10,220	1,233,000	10,625	766,000	8,230
Vitrified brick-----	180,000	1,650	600,000	6,000	500,000	5,000
Fire brick-----	55,000	550	-----	1,203	407,500	5,250
Earthenware-----	-----	4,490	-----	658	-----	612
Stoneware-----	-----	17,453	-----	13,854	-----	13,700
Decorated ware-----	-----	552	-----	-----	-----	-----
Sewer pipe, tile, etc.-----	-----	55,745	-----	72,618	-----	100,989
	<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>	
Kaolin-----	15,575	119,172	13,322	108,105	8,605	76,000
Fire clay-----	-----	100	-----	215	231	875
Total value-----	-----	907,793	-----	908,105	-----	942,458

	1904.		1905.		1906.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Common brick-----	143,988,850	\$795,494	153,610,000	\$896,289	166,338,000	\$1,041,078
Pressed brick-----	1,510,000	17,375	875,000	13,925	385,000	4,410
Vitrified brick-----	430,000	3,850	400,000	3,600	400,000	4,000
Fire brick-----	163,000	2,700	681,000	8,233	401,000	7,180
Earthenware-----	-----	438	-----	387	-----	713
Stoneware-----	-----	13,462	-----	12,932	-----	11,057
Decorated ware-----	-----	-----	-----	-----	-----	-----
Sewer pipe, tile, etc.-----	-----	110,800	-----	102,445	-----	113,900
	<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>	
Kaolin-----	9,110	76,670	10,988	85,622	10,803	90,036
Fire clay-----	202*	761	107*	519	207	322
Total value-----	-----	1,021,550	-----	1,124,052	-----	1,272,696

*Including ordinary stoneware clay sold crude.

The statistics given in this table do not, perhaps, represent the total output of all the clay production of the State, for the reason that in many of the counties there are a few thousand brick made for local

purposes regarding which it is extremely difficult or impossible to obtain statistics, this being especially true where the brick are not for sale, but are used directly by those manufacturing them.

SUMMARY.

The 1906 mineral production was obtained from 80 counties as compared with 78 counties in 1905, and in the following table the value of the productions for the years 1905 and 1906 in each county is given:

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH CAROLINA
IN 1905 AND 1906.

County.	1905.			1906.		
	Mineral Pro- duction, Including Kaolin.	Clay Products, Except Kaolin.	Total.	Mineral Pro- duction, Including Kaolin.	Clay Products, Except Kaolin.	Total.
Alamance		\$ 27,950	\$ 27,950		\$ 25,650	\$ 25,650
Alexander	600		600	350		350
Alleghany				500		500
Anson		1,500	1,500		3,000	3,000
Ashe	830		830	4,970		4,970
Beaufort		15,250	15,250		17,300	17,300
Bertie		450	450		147	147
Bladen		750	750		2,450	2,450
Brunswick						
Buncombe	35,607	36,785	72,392	35,331	45,460	80,791
Burke	1,015	6,250	7,265	20,357	8,551	28,908
Cabarrus	23,489	69,450	92,939	24,742		24,742
Caldwell		16,500	16,500		7,200	7,200
Camden						
Carteret						
Caswell						
Catawba	3,581	16,705	20,286	10,418	28,280	38,698
Chatham	2,336	2,000	4,336		1,500	1,500
Cherokee	29,459		29,459	16,578		16,578
Chowan		7,700	7,700		7,500	7,500
Clay	7,500		7,500			
Cleveland	73,017	4,800	77,817	52,138	7,711	59,849
Columbus		12,500	12,500		14,000	14,000
Craven		48,765	48,765		11,400	11,400
Cumberland		16,500	16,500		27,750	27,750
Currituck						
Dare						
Davidson	1,420	19,000	20,420	1,355	18,000	19,355
Davie	3,850		3,850		1,238	1,238
Duplin		263	263		5,622	5,622
Durham		57,063	57,063		50,510	50,510
Edgecombe		31,150	31,150		44,800	44,800
Forsyth		56,015	56,015		82,796	82,796
Franklin		14,500	14,500	608	7,000	7,608
Gaston	3,365	11,520	14,885	1,844	43,348	45,192
Gates						
Graham						
Granville	12,000		12,000	10,000		10,000
Greene		5,420	5,420		4,700	4,700
Guilford	9,108	145,299	154,407	6,603	167,677	174,280
Halifax		26,950	26,950		33,800	33,800
Harnett		700	700		3,900	3,900
Haywood	35,210	3,025	38,235	21,975	2,400	24,375
Henderson	11,880	5,000	16,880	48,267	15,250	63,517
Hertford						
Hyde						
Iredell	2,063	7,200	9,263	2,950	21,100	24,050
Jackson	79,350		79,350	90,995	100	91,095
Johnston		22,490	22,490		23,490	23,490
Jones						

VALUE OF MINERAL PRODUCTION BY COUNTIES—CONTINUED.

County.	1905.			1906.		
	Mineral Production, Including Kaolin.	Clay Products, Except Kaolin.	Total.	Mineral Production, Including Kaolin.	Clay Products, Except Kaolin.	Total.
Lenoir	\$-----	\$ 3,500	\$ 3,500	\$-----	\$ 55,850	\$ 55,850
Lincoln	-----	2,199	2,199	6,310	7,357	13,667
McDowell	20,153	3,800	23,953	31,357	2,000	33,357
Macon	2,000	-----	2,000	48,966	750	49,716
Madison	23,185	625	23,810	10,020	900	10,920
Martin	-----	-----	-----	-----	100	100
Mecklenburg	7,462	27,500	34,962	8,964	37,500	46,464
Mitchell	89,927	-----	89,927	131,078	-----	131,078
Montgomery	62,650	-----	62,650	61,650	-----	61,650
Moore	13,682	9,954	23,636	17,173	11,650	28,823
Nash	2,006	9,000	11,006	1,305	13,750	15,055
New Hanover	34,405	16,500	50,905	41,083	21,000	62,083
Northampton	-----	-----	-----	-----	-----	-----
Onslow	-----	-----	-----	-----	1,010	1,010
Orange	13,340	2,750	16,090	17,904	3,175	21,079
Pamlico	-----	-----	-----	-----	-----	-----
Pasquotank	-----	13,600	13,600	-----	13,650	13,650
Pender	-----	3,000	3,000	-----	3,600	3,600
Perquimans	-----	1,330	1,330	-----	2,100	2,100
Person	-----	-----	-----	56,779	-----	56,779
Pitt	-----	6,950	6,950	-----	9,909	9,909
Polk	25,703	-----	25,703	27,880	-----	27,880
Randolph	-----	14,093	14,093	7,500	12,617	20,117
Richmond	2,000	-----	2,000	12	-----	12
Robeson	1,000	16,888	17,888	-----	21,759	21,759
Rockingham	-----	14,450	14,450	60,394	12,750	73,144
Rowan	334,454	21,800	356,254	447,753	24,300	472,053
Rutherford	34,320	2,556	36,876	25,110	4,187	29,297
Sampson	-----	-----	-----	-----	-----	-----
Scotland	4,450	1,800	6,250	10,000	1,200	11,200
Stanly	10,140	-----	10,140	10,150	-----	10,150
Stokes	3,000	7,000	10,000	3,773	-----	3,773
Surry	219,883	5,080	224,963	256,428	39,000	295,428
Swain	65,212	-----	65,212	69,665	-----	69,665
Transylvania	600	-----	600	12,043	-----	12,043
Tyrrell	-----	-----	-----	-----	-----	-----
Union	4,977	22,400	27,377	5,035	19,206	24,241
Vance	7,150	-----	7,150	13,100	-----	13,100
Wake	475	32,684	33,159	475	26,342	26,817
Warren	38,010	-----	38,010	23,653	-----	23,653
Washington	-----	800	800	-----	1,100	1,100
Watauga	350	-----	350	916	-----	916
Wayne	3,185	59,563	62,748	1,025	63,413	64,438
Wilkes	63	11,320	11,383	1,200	4,730	5,930
Wilson	-----	37,000	37,000	-----	34,125	34,125
Yadkin	-----	838	838	-----	-----	-----
Yancey	39,300	-----	39,300	64,684	-----	64,684
Unknown	2,189	-----	2,189	1,575	-----	1,575
Totals	1,400,951	1,038,430	2,439,381	1,824,941	1,182,660	3,009,601

As is seen from the above table, the following counties reported no production of mineral of any kind during 1906: Brunswick, Camden, Carteret, Caswell, Clay, Currituck, Dare, Gates, Graham, Hertford, Hyde, Jones, Northampton, Pamlico, Sampson, Tyrrell and Yadkin. Of these counties, the following reported a production in 1905: Clay and Yadkin. There were 4 counties—Alleghany, Martin, Onslow and Person—which reported a production in 1906, but none in 1905.

Of the 80 counties reporting a mineral production for 1906, there were only 51 counties that reported anything besides clay products. Of 61 counties reporting a production of clay, 26 counties did not report any other production. There were 19 counties reporting a mineral production which did not include any clay products. Rowan County continues to lead in the value of her mineral production, excepting clay products, the value being \$447,753; while Guilford County still reports the greatest value of clay products, \$167,677. The county reporting the greatest value for its total mineral production in 1906 was Rowan, with a value of \$472,053. Surry County was second in the value of her total mineral production, which was \$295,428. The lowest value reported by any county for its mineral production was \$12 in Richmond County.

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THE NORTH CAROLINA GEOLOGICAL AND
ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 15

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1907

WITH

SPECIAL REPORT ON THE MINERAL WATERS

BY

JOSEPH HYDE PRATT, Ph. D.



RALEIGH

E. M. UZZELL & Co., STATE PRINTERS AND BINDERS

1908

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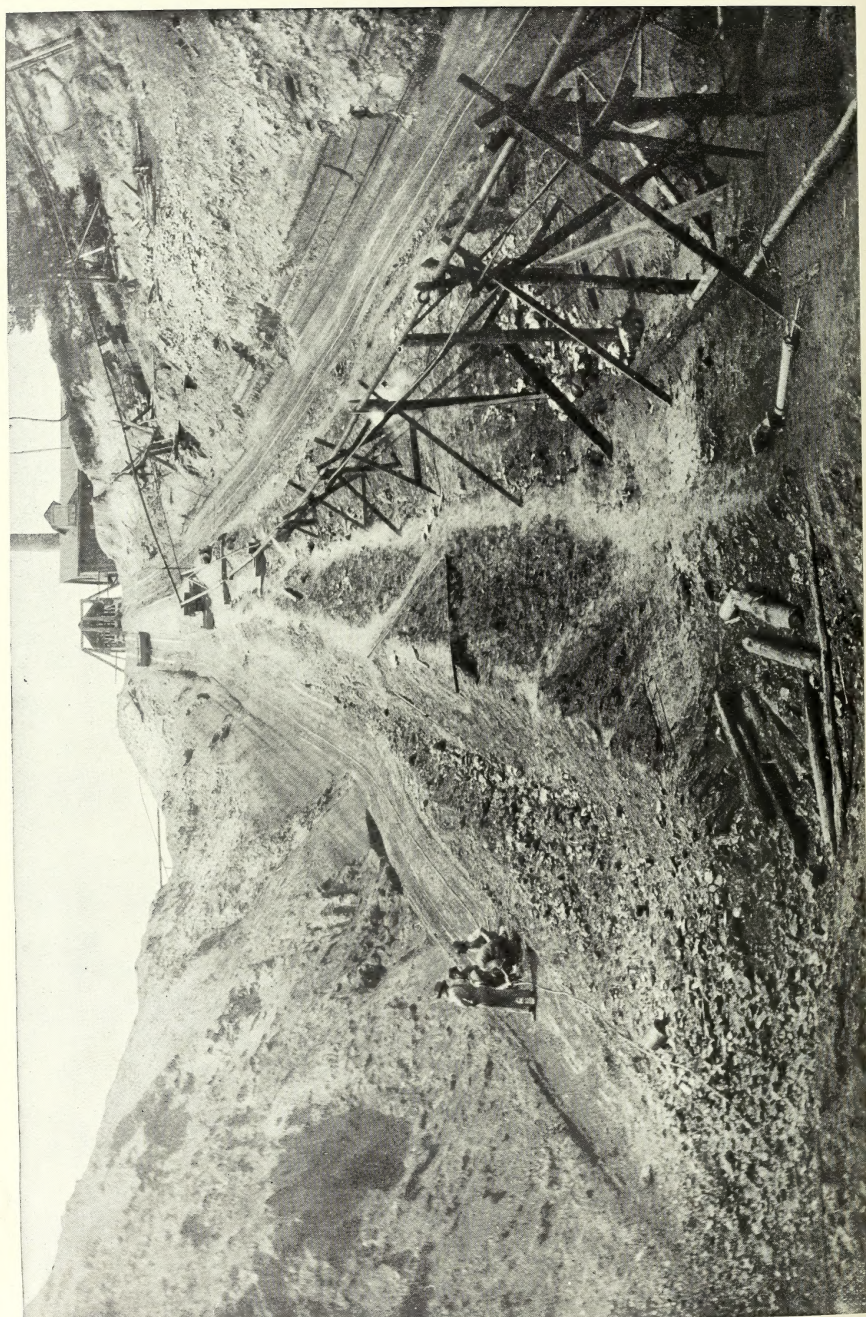
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OPEN PIT AT THE SHUFORD MINE, CATAWBA COUNTY, N. C. AUTOMATIC SCRAPER NEAR TOP.

MINING INDUSTRY IN NORTH CAROLINA DURING 1907.

By JOSEPH HYDE PRATT.

INTRODUCTION.*

Notwithstanding the fact that the last six months of the year 1907 were marked by a financial panic and general business depression, there was a decided increase in the total value of the mineral production in North Carolina during the past year over that of the previous year. There were two mineral products, building stones and clay products, that it was expected would show a considerable falling off in value, as they are so dependent upon building industries, which were seriously affected by the business depression. Both these products, however, showed a decided increase in the value of their production as compared with the previous year. With the increased demand for timber and the corresponding gradual but constant advance in price for this building material, there is a growing demand for other forms of structural material, as brick, sand-lime brick, granite, limestone, etc. This will cause an additional increase in the production of such materials beyond that ordinarily expected from the regular increase in construction work in a State.

Of the metallic minerals, there was a slight increase in the production of iron, but a decided decrease in the production of gold, silver and copper. This latter decrease was due to the sharp decline in the price of copper during the latter half of 1907, which resulted in the closing down of nearly all the copper mines in the State.

Of the non-metallic minerals, there was a slight increase in the production of mica, for which North Carolina is especially noted, and in talc and soapstone. The production of monazite, however, which had been steadily increasing up to the past year, showed a very large decrease, which was due to the low value of thorium nitrate, which is the commercial salt derived from monazite.

On the whole, however, the results of 1907 show that the mining and quarrying industries of the State are in a most prosperous condition and that, although some of them are developed to but a slight degree of what they are capable, they are yet in such a condition that such further development is practicable. One of the greatest influences

*The North Carolina Geological and Economic Survey has co-operated with the United States Geological Survey in the collection of the mineral statistics used in this report.

that has reacted in favor of the development of the various minerals of the State has been the more systematic advertising of the mineral resources not only by the State bureaus, but also by the individuals and corporations owning the mines and quarries.

There are many favorable forms of investment that can be made in this State in mineral properties, some of which would necessitate the establishment of manufacturing plants either at or close by the mineral deposit in order to utilize the mineral and convert it into a commercial product. This is especially true of certain of the clay deposits.

There is one point that must be taken into consideration in connection with mining or prospecting for minerals in North Carolina, and that is that the State is a well settled, farming one and there are no State or Federal lands which offer special privileges or inducements to prospectors, as is the case in the west where mineral and mining claims can be taken up on the Federal domain. The only land belonging to the State is certain areas of swamp lands in the extreme eastern portion of North Carolina. It is also often difficult to make satisfactory arrangements with the property holders for prospecting, and propositions for such work from outsiders are often regarded as an intrusion and with suspicion. For these reasons it is more difficult to locate good properties, and many valuable mineral deposits have been the result of the accidental finding of the ore.

In connection with the work of the North Carolina Geological and Economic Survey, where various sections of the State are being examined by its geologists, any information of value obtained regarding these sections is always given to the landowner before same is published. The members of the Survey staff are always ready and willing to give any assistance and information regarding any mineral property when they happen to be working in the vicinity where such property is located.

The total value of the mineral production of North Carolina* during 1907 was \$3,173,722, as compared with \$3,007,601 in 1906, an increase of \$166,121. The production of 1906 was also a decided increase over that of 1905, amounting to \$568,220, this making a total increase in the mineral production for the two years of \$734,341. In order to show more strikingly the general increase in the value of the various minerals produced in North Carolina for the past five years, there is given in the following table the production of each mineral produced in the State from 1903 to 1907 inclusive.

*In the collection of the production of the various minerals, the State Survey has had the co-operation of the Department of Mineral Resources of the United States Geological Survey.

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS 1903-1907.

Mineral.	Value.				
	1903.	1904.	1905.	1906.	1907.
Gold	\$ 113,604	\$ 123,924	\$ 129,153	\$ 122,008	\$ 82,195
Silver	16,907	19,132	20,216	30,944	14,299
Copper	67,037	36,600	88,000	135,829	116,416
Iron	78,540	79,846	70,352	75,638	113,488
Pyrite					
Garnet					
Corundum	12,250	6,586	9,000		13,500
Millstones	902	6,500	2,652	4,110	1,969
Mica { Sheet	86,300	100,724	100,900	205,756	209,956
{ Scrap	2,400	3,410	3,375	11,940	15,250
Quartz	36,827	36,269	13,659	12,578	1,664
Precious stones	1,525	10,600	3,350	5,000	7,580
Rare minerals	270	160			9,300
Monazite	58,694	79,438	107,324	125,510	54,824
Zircon	570	200	1,600	248	46
Barytes	21,347	33,930	21,670	10,020	18,855
Talc and pyrophyllite	76,984	65,483	74,940	66,979	74,347
Mineral water	13,085	21,902	38,755	31,413	40,302
Graphite	248	525	475		
Coal	25,300	8,820	2,336		
Stone	360,322	312,576	597,922	854,301	956,919
Sand and gravel			547	9,191	2,191
Sand-lime brick		17,500	29,103	32,975	38,808
Kaolin	76,000	76,670	85,622	90,036	85,505
Clay products	866,458	944,880	1,038,430	1,182,660	1,316,308
Total value	1,915,570	1,985,675	2,439,381	3,007,601	3,173,722

The following minerals and ores have been mined in North Carolina during 1907 and are discussed in this report in the order given: Gold and Silver; Copper; Iron; Tin; Abrasive Materials (including Garnet and Millstones); Mica; Quartz (Flint); Barytes; Monazite and Zircon; Talc and Soapstone; Precious Stones; Mineral Waters; Graphite; Coal; Peat; Stone (Granite, Sandstone, Marble and Limestone); Sand and Gravel; Sand-lime Brick; Kaolin and Clay Products.

GOLD AND SILVER.

In the report on the Mining Industry for 1906 considerable space was devoted to a discussion of the gold and silver deposits of the State. Many of the properties were described in detail, and there was a full discussion of those changes in mining practice that had resulted favorably to the development and mining of these metals. In the present report only those properties will be described that have been developed to a considerable extent during the past year or are new properties. For location of gold mines, see Fig. 1, which has been reproduced from map of U. S. Geological Survey.

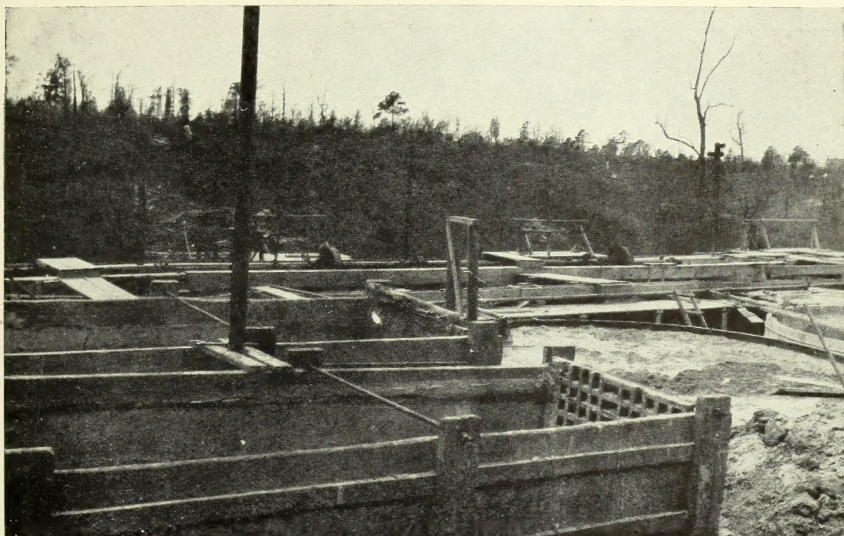
The Iola Mine, near Candor, Montgomery County, continues to be the largest producer of gold in the State. This mine is on a vein that dips about 45° to the SE. and is parallel to the so-called slates, striking N. 55° E. In width it varies from 2 to 8 feet, and has all the appearance of being replacement of the country rock, there having existed previously a crevice or line of fracture which has been enlarged by

solutions and either the country rock directly replaced by quartz or the enlarged fissure has later been refilled. The value of the ore taken out during the past year varies from a few dollars to over \$30 per ton, some places having been opened up that showed a thickness of 8 feet of a soft, white, sugary quartz containing \$30 per ton in gold. In two places the vein has pinched out to a mere stringer which may open up again in a short distance into a vein of sufficient width to mine. The values in the vein are irregular and there are richer shoots of ore, the main one extending from 100 to 150 feet along the vein and continuing from the surface down to the lowest level to which work has been extended, 320 feet on the incline. The values in the lower portion of this shoot are somewhat less than at the upper levels. Besides this main shoot, there are several smaller ones, usually about 30 inches thick in the middle, extending something like 30 feet along the strike. The ore in some of these is composed of sugary quartz with visible gold and others are hard, vitreous quartz with included masses of unaltered slate. Along the contacts of these included masses of slate is occasionally found coarse gold in octahedral crystals up to $\frac{1}{4}$ inch in diameter.

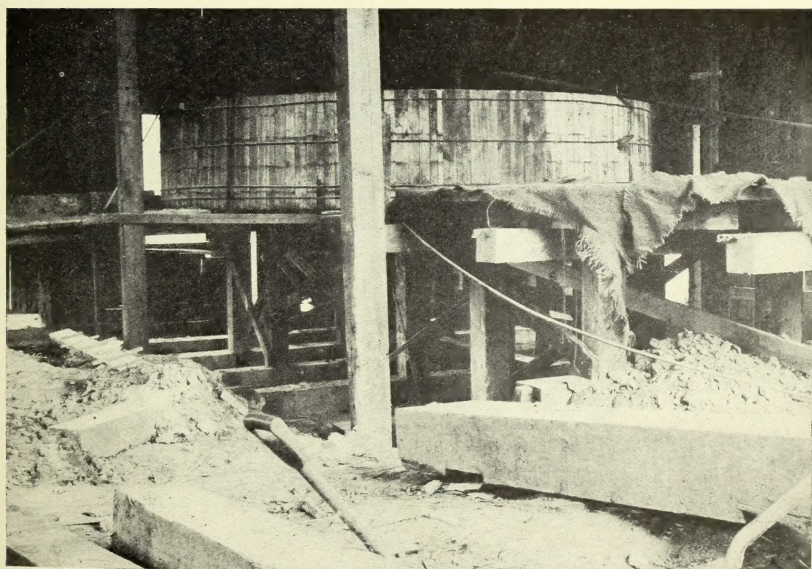
A new 3-compartment incline shaft has just been driven which will become the main working shaft. It will be sunk to a depth of 600 feet, when it is expected it will intercept the vein. All the ore will be brought out of the mine through this shaft and delivered by gravity directly to a new 40-stamp mill that has just been installed. The cyanide plant has also been rebuilt and now there is a considerable saving in cost of production, due to less handling of the ore than when the old stamp and cyanide mills were in use.

Nearly all the coarse gold and much of the fine is amalgamated, the tailings, which vary from \$2 to \$4 per ton, being run to the cyanide plant. These tailings pass first into settling tanks or, as they are called at the mine, sand boats, that are 3 feet wide at one end, 4 feet at the other, 12 feet long and $3\frac{1}{2}$ feet deep (see Pl. II, A). At the small end is a wooden lattice on the inner side of which a canvas curtain may be rolled up from the bottom.

The wet sand from these boats is shoveled out and dumped to one side, where it is allowed to drain and become partly dried. From this pile the sand is wheeled in wheelbarrows over to the sand tanks and dumped. These tanks are 20 feet in diameter, 4 feet deep, and made of yellow pine. There is the usual cocoa-matting filter in the bottom, such as has already been described. They hold, when filled to a convenient height, 40 tons of sand (Pl. II, B). The sand is smoothed off and then the solution of potassium cyanide of .05 per cent strength



A, SETTLING TANKS, IOLA MINE, MONTGOMERY COUNTY.



B, CYANIDE TANKS IN COURSE OF CONSTRUCTION, IOLA MINE, MONTGOMERY COUNTY.

(1 pound of potassium cyanide per ton of water) is poured onto the sand. This solution is kept circulating as rapidly as possible for three or four days. It is usually allowed to drain down until the sand becomes exposed, when it is again filled up. At the end of this time the solution is allowed to drain off, after which a little water is used to displace what solution remains in the damp sand. The first solution is led to the strong gold solution tank and the washings to the weak solution tank. The sand is then washed out by a stream of water from a hose through a door or opening in the side of the tank. The slimes flow from the sand boats to one of three agitation tanks that are 10 feet deep and 20 feet in diameter. Near the bottom of each of these a paddle consisting of four well-braced oak arms carrying pins slowly revolves. A solution of cyanide is permitted to enter the slime tanks at the same time with the slimes. The strength of this solution is such that, combining with the water mixed with the slimes, will make it approximately .05 per cent solution.

The agitation continues while the tank is being filled and at the same time air is introduced by means of a pipe connected with an air compressor. When one of these agitation tanks is filled, the slimes are led to a second and then a third. The process continues until the tank is needed for more slimes. The slimes in solution are then drawn off at the bottom and passed into settling tanks 14 feet deep by 18 feet in diameter at a lower level. Here the solid matter slowly settles out and then the clear solution is drawn off and stored in the weak solution gold tank, from which it is later led to a special set of zinc boxes.

The solution from the sand tank which contains the gold is not stored, but passes directly to the zinc boxes. These have six compartments, $2 \times 2 \times 2\frac{1}{2}$ feet, with a side trough and diaphragm for circulating the solution. This arrangement allows any one box to be emptied and cleaned while the solution circulates through the others. From the zinc boxes the solution flows to a sump tank 10×20 feet, where more potassium cyanide is added to replace what has been consumed, until the solution reaches the right strength. This sump tank therefore serves also for a stock solution tank from which the solution is raised by a small centrifugal pump to the sand-leaching tanks.

The clear solution from the slime-settling tank, which is stored in the weak-solution gold tanks, flows through an 8-compartment zinc box made similarly to the other and then to a sump or weak-solution tank. Most of the gold is precipitated in the first box. Each month the zinc in the box is sifted and the fine stuff saved, while the coarse is returned to the box. The deficiency of coarse zinc in the first box is made up by taking some of it from the second, which is in turn filled from the third,

etc. All the fresh zinc required is added to the last compartment. The fine particles of zinc that are sifted out are saved, as they often contain a coating of gold, and, when the accumulations amount to a sufficient quantity, they are treated and the gold saved.

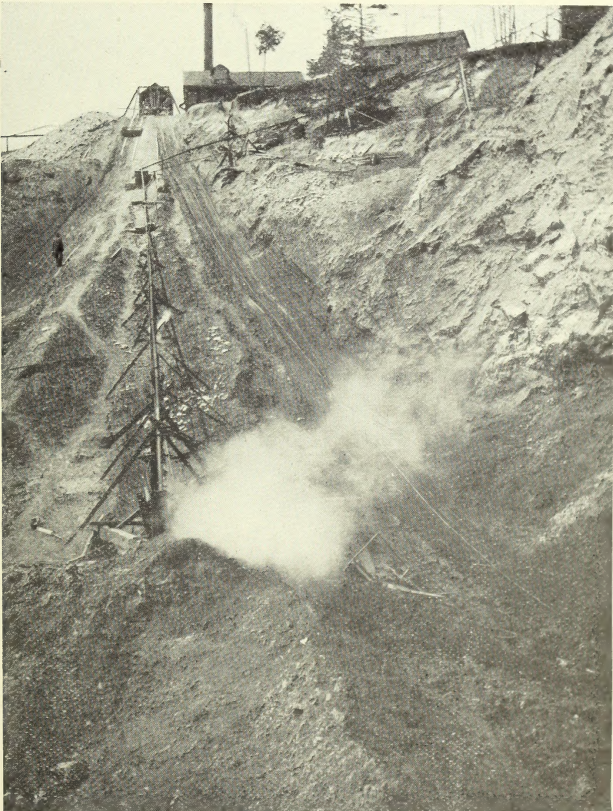
The gold slimes or finely divided gold containing small scraps of zinc are melted in a graphite crucible, to which a little nitre is added to oxidize the zinc and unite with the borax, which is used as a flux. The melted gold is then cast into bricks and sent to the mint.

Eight pounds of lime are added to each ton of tailings as they are dumped into the sand tanks. A small amount of lime is also added to the slimes as they are running into the slime tank. This ore is very free from other elements that would react on the cyanide solution, with the exception of some acid sulphate formed from the pyrites, which is neutralized by the lime, and therefore the principal loss of cyanide is that wasted with the wet slimes. The tailings from the cyanide plant contain about 50 cents gold per ton.

The next largest producer of gold in the State during 1907 was the Shuford Mine. This mine is situated in Catawba County, $4\frac{1}{2}$ miles slightly south of east of Catawba, a station on the Southern Railway. The mining tract comprises about 425 acres, of which 20 acres is the part that contains the workable mineral deposit. This latter area is covered with auriferous quartz and the soil is also auriferous. The underlying schists and gneisses were found to be penetrated by seams of auriferous quartz which run in every direction. There are, however, no veins, strictly speaking, although some of the quartz seams are several inches in thickness and are persistent for a considerable distance in length and depth. The entire surface for a width of 300 or more feet and for a distance of 1,000 or 2,000 feet is pay material. When the property was first opened an attempt was made to mine the ore by sinking shafts, running drifts and then stoping, but was practically a failure from the start. One shaft was sunk to a depth of 115 feet and several levels started from this and considerable ore stoped out. Although many of the narrow quartz seams contain gold in some quantity, it was too expensive mining this on account of the amount of waste material which had to be removed. About 1904, after the property had been closed for some years, it was bought, principally on account of the depth to which the saprolitic rocks extended and because of their area. It was the desire of the purchasers to test the practicability of a new type of log-washer in saving gold from such saprolitic rocks. As described in Economic Paper 14, page 19, the process was a success. Instead of attempting to mine the ore by stoping and trying



A, SCRAPER IN USE AT THE SHUFORD MINE, CATAWBA COUNTY.



B, OPEN CUT OF THE SHUFORD MINE, CATAWBA COUNTY.

to eliminate the low-grade material, a method of open-pit work was introduced and all the material taken out was treated in the separators.

When this method of mining was first started,* the ore was drawn out of the pit by means of a skip running on a wooden track, which was self-dumping, and discharged on a grizzly at the top of the pit. While this method handled the ore very cheaply, more economy was desired, and finally an ingenious method was devised consisting of self-loading scrapes holding from $\frac{3}{4}$ to nearly 2 tons of ore. See Pl. III, A and B. There are two of these scrapes on an endless wire rope, the loading scrape pulling the empty one back down into the pit. The ore is broken down from the sides of the pit by blasting with powder from 20-foot holes, using 2 to 3 kegs of powder. The material loosened falls in piles at the bottom of the pit. The scrapes, as they are pulled back into the pit, are hauled over this material and then, when started toward the surface, their own weight causes the edge of the scrape to be pulled down into the ore and they are readily filled by the pull of the cable. A scrape can be loaded and dumped in the hopper about every 75 seconds.

The scrapes are 5 feet wide, $5\frac{1}{2}$ to 6 feet long and 18 inches high at the rear, tapering somewhat toward the front end. (See Pl. III, A.) The bottom of the scrape only extends for a distance of about 18 inches, the ore between the balance of the side pieces of the scrape resting on the ground. These scrapes run in a trough or trench in the ground, the steeper portions of which are protected by scantling. (See Pl. III, A, and Pl. I.) As the scrape comes to the top, it runs over a hopper and the mass of ore immediately drops out. A special blade and handles permit the emptying of the scrape in a few seconds.

The hopper is in the shape of a circular trough made of boiler plate into which two streams of water are flowing which are of sufficient volume and strength to wash the ore through a grizzly and then through the concentrating machines. (See Pl. III, A.)

As one can readily see, a profitable method to treat these ores that only carry from 50 cents to \$1 per ton in gold must be simple, economical and thorough. This new separator does its work efficiently, saving approximately 85 per cent of the values, even though the gold may be in a very finely divided state. The principal cost in using this machine is in the mining operations, and the only practical method for mining ores of this type would be by means of open cuts and pits. The entire expense of handling the ore after it has been brought to the hopper should not be more than 15 to 18 cents per ton, and should be reduced even below these figures. One machine consisting of two

*Economic Paper No. 14, pp. 19-26. Log washers, by A. A. Steel and Joseph Hyde Pratt.

washers will handle at least 100 tons of ore in 10 hours, and can be pushed up so as to handle 125 tons. They require only 75 gallons of water per minute and a 15-horse power engine is sufficient to run one machine.

These modern pulverizing and concentrating machines have been installed at the Catawba Mine, at the Laffin Mine near Cox, Randolph County, at the Troy Mining Company's property 7 miles north of Troy, Montgomery County, at the Sawyer Mine in Randolph County, at the Merrill Mine 3 miles west of Sophia, Randolph County, and at the property of the Gold Valley Mining Company at Gold Valley, Rutherford County, 4 or 5 miles from Brindletown.

There were a number of properties in the State at which a great deal of development work was done during 1907, but which made no production of gold or silver. Some of these, as the Sawyer Mine in Randolph County, the Parker Mine in Stanly County, the Pine Hill and Pilot Mountain mines in Randolph County, the Gold Valley Mine in Rutherford County, and the mine at Teer, 8 miles from Chapel Hill, Orange County, will undoubtedly be producers in 1908.

Dredging has been carried on to some extent on the Catawba River by Mr. Edgar L. Brown, of Charlotte, N. C., and near Ransome's Bridge, Halifax County.

Silver.—Nearly all of the silver produced in North Carolina is obtained as a by-product from copper ores, there being but a very small per cent obtained from the gold ores, the North Carolina gold being noted for its fineness. Of the total production of silver, \$14,299, only a few hundred dollars were obtained from the gold ores, the balance being obtained from the copper ores. Thus it is seen that any decided decrease in the production of the copper ores means also a decrease in the production of silver.

PRODUCTION.

The total production of gold and silver during 1907 was \$96,494, coining value, which is a decrease of \$56,458 as compared with \$152,952, the value of the production of 1906. Of this 1907 production, \$82,195 was due to the value of the gold produced, which is a decrease of \$39,813 as compared with \$122,008, the value of the 1906 production. The coining value of the silver produced was \$14,299 as compared with \$30,944, the value of the 1906 production, this being a decrease of \$16,645, and is due to the smaller production of copper.

Montgomery County continued to be the largest producer of gold and Catawba was second. The largest production of silver was from Rowan and the second largest from Person, both of these counties also being the largest producers of copper. In the following table there is

given a rough estimate of the production of gold and silver in 1906 and 1907 by counties, which will illustrate the distribution of the production throughout the State.*

PRODUCTION OF GOLD AND SILVER IN 1906 AND 1907 BY COUNTIES.†

County.	1906.			1907.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Burke	\$ 550	\$ 7	\$ 557	\$ 2,976	\$ 13	\$ 2,989
Cabarrus	17,500	50	17,550	1,521	1	1,522
Catawba	6,600	110	6,710	6,274	45	6,319
Cleveland	1,000	10	1,010			
Davidson	750	300	1,050	386	109	495
Franklin	8	600	608	1,186	2	1,188
Gaston				300		300
Granville				145	2,226	2,371
Guilford	6,500	25	6,525	1,863		1,863
McDowell	800	12	812	222	1	223
Mecklenburg	3,500	15	3,515	7,744		7,744
Montgomery	60,100	1,500	61,600	52,438	410	52,848
Moore				225	1	226
Nash	1,300	5	1,305			
Person	200	8,750	8,950	145	2,226	2,371
Randolph				300		300
Rowan	7,000	19,000	26,000	3,683	9,243	12,926
Rutherford				223	1	224
Stanly	10,000	150	10,150	50		50
Union	5,000	35	5,035	500	21	521
Unknown	1,200	375	1,575	2,014		2,014
Total	122,008	30,944	152,952	82,195	14,299	96,494

*The gold and silver statistics have been obtained through the courtesy of Mr. George C. Roberts, Director of the Mint, Washington, D. C. The counties given in this table do not represent all the producing counties, but the production has been given, as far as possible, of the principal producing counties and the balance is given as "Unknown." This latter undoubtedly includes a dozen or more counties.

†Coining value.

The next table gives the value of the gold and silver produced in North Carolina for the years 1882 to 1907, inclusive:

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1882 TO 1907.*

Year.	Gold.	Silver.	Total.
1882	\$190,000	\$ 25,000	\$215,000
1883	167,000	3,000	170,000
1884	157,000	3,500	160,500
1885	152,000	3,000	155,000
1886	175,000	3,000	178,000
1887	225,000	5,000	230,000
1888	136,000	3,500	139,500
1889	145,000	3,878	148,878
1890	118,500	7,757	126,257
1891	95,000	6,465	101,465
1892	78,560	12,671	91,231
1893	53,600	17,325	70,925
1894	46,594	455	47,049
1895	54,200	520	54,720
1896	44,300	646	44,946
1897	34,600	388	34,988
1898	84,000	905	84,905
1899	34,500	388	34,888
1900	44,653	15,986	60,639
1901	60,410	34,023	94,433
1902	93,650	30,212	123,862
1903	113,604	16,907	130,511
1904	123,924	19,133	143,057
1905	129,153	20,216	149,369
1906	122,008	30,944	152,952
1907	82,195	14,299	96,494

*Coining value.

COPPER.

As stated in the report for 1906, the Geological Survey is making a thorough investigation of the copper mines and copper deposits of the State, and in that report there is a brief description given of the copper areas of Swain County. In the present report a brief description with illustrations is given of the copper belt of Rowan and Stanly counties, known as the Gold Hill District. This investigation has been made by F. B. Laney, assisted by J. E. Pogue, Jr., and under the supervision of the State Geologist.

THE GOLD HILL COPPER DISTRICT.

BY F. B. LANEY.

Location.—The Gold Hill copper district is located principally in the southeastern portion of Rowan County, but includes a portion of the northeastern part of Cabarrus and a narrow strip of the northwestern part of Stanly counties. (See Figs. 1 and 2.) It lies in the south central portion of the State and its eastern boundary is about 35 miles west of the eastern limits of the Piedmont Plateau. It consists of a strip about 18 miles long and 8 miles wide, extending from the Yadkin River on the northeast to near the village of Mt. Pleasant on the southwest, the center of mining, the village of Gold Hill, being located approximately in its center.

The principal surface features of the district are a low-lying, flat-topped ridge, the Gold Hill ridge, which extends from about 2 miles southwest of the village of Gold Hill to and beyond the Yadkin River, and a series of hills, the Beaver Hills, lying between the village and Buffalo Creek. For the most part there is little relief but the hills just mentioned and the northeast portion of the Gold Hill ridge, especially the latter. The Gold Hill ridge forms the watershed of the district. The streams to the northwest of this ridge flow northeast into the Yadkin River and those to the southeast flow southeast into Rocky River. The principal streams are the Yadkin River, which forms the northeast boundary of the district; Second Creek, flowing northeast into the Yadkin River, and Buffalo Creek, which flows southeasterly across its southwestern portion.

The district may be reached by the Southern Railway, the Norwood branch of which crosses it at Gold Hill nearly at right angles. The nearest town of any size is Salisbury, about 15 miles northwest of Gold Hill.

General description of the rocks of the district.—The area is about equally divided between igneous and plastic rocks. The eastern portion comprises the great series of "slates," intercalated in which are irregular

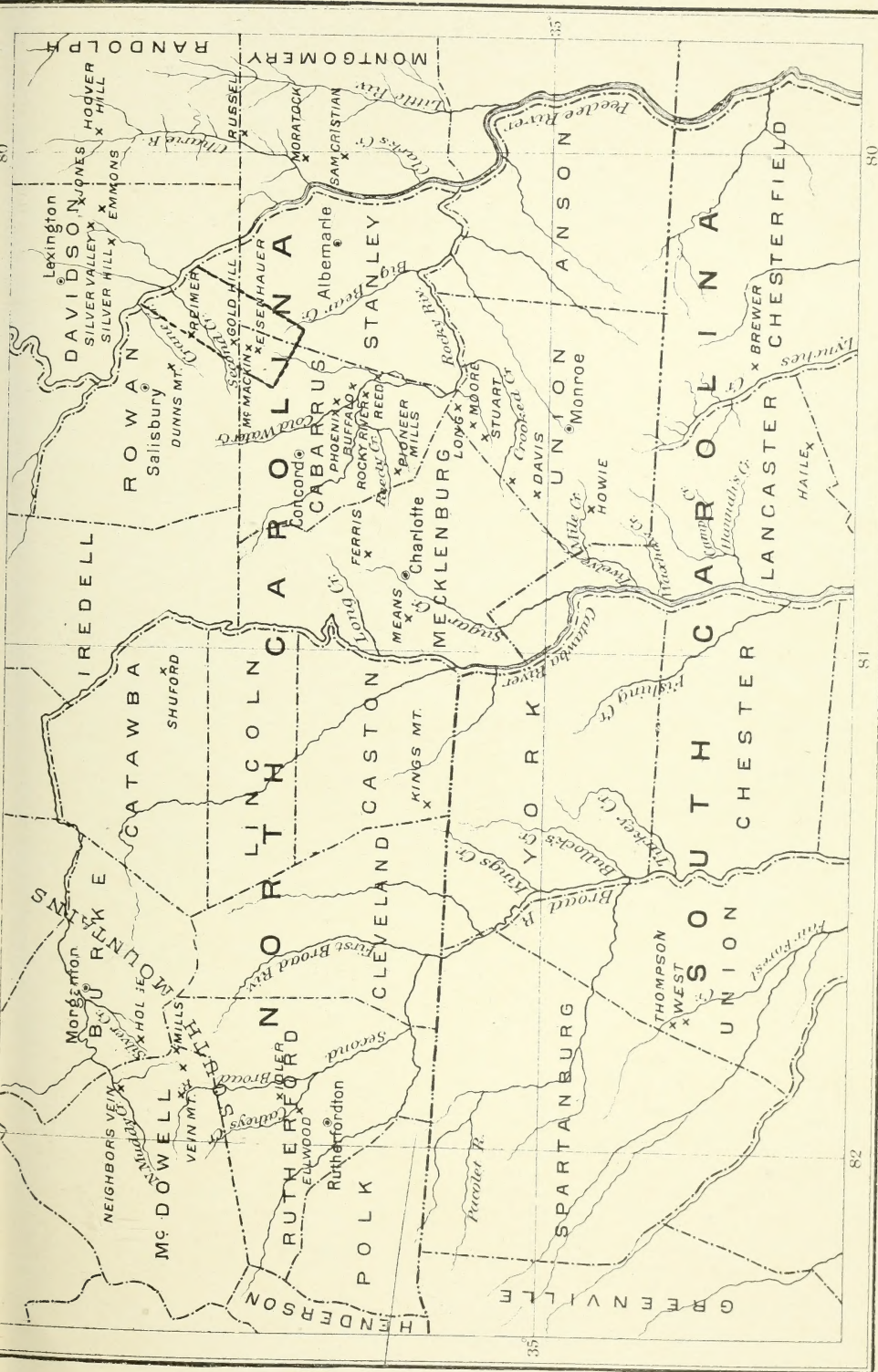


FIG. 1.—Map of CENTRAL NORTH CAROLINA SHOWING LOCATION OF THE PROMINENT COPPER AND GOLD MINES (X).
* Reproduced from Map of U. S. Geological Survey.

bands and long lenses of volcanic rocks representing tuffs, breccias, and flows, of which there are two types—rhyolitic and andesitic. The western portion is made up wholly of igneous rocks. There are three general types—greenstone, diorite, and granite, together with numerous dikes of both acid and basic character. Each type shows more or less variation and local differences. In a general way, it may be said, taking the rocks in order of their relative ages, that the greenstone with its local tuffaceous phases is the oldest and most highly metamorphosed rock in the area, the diorite next in order, and the granite least of all. There are at least four types of rock occurring as dikes, the character of which varies as to the relative time of intrusion. The oldest dikes are those of diorite and are found cutting only the greenstone. Following this series come the granite and quartz-porphyry dikes, which are found cutting both the greenstone and the diorite. Next in order come a series of dikes of a fine-grained rock which resembles very closely a diorite, and which are found cutting both the granite and the massive diorite. Finally and last of all is a series of gabbro and diabase dikes, the latter of which are probably of triassic age, and are found cutting all the other rocks of the district.

The Greenstone.—This is probably the oldest rock in the area and consequently presents a higher degree of metamorphism than any of the other rocks. The massive phases of this rock are dark in color, medium- to fine-grained, and present phenocrysts of both plagioclase and green hornblende. With this are found tuffaceous phases of the same rock, which, from their general appearance, one would think were laid down by water. These tuffaceous phases of the rock lie to the east of the more massive facies and are in the area which has suffered the greatest dynamic metamorphism. So great, indeed, has been this metamorphism that one may characterize the greater part of the rocks of the greenstone area as greenstone schists. This greenstone is the rock into which the great diorite mass lying to the west was intruded. This is conclusively shown by the nature of the contact of the two rocks. Exposures of the contacts are scarce, being nearly always obscured by the great mass of rock decay, but where they are found the diorite clearly makes a contact against the greenstone. That is, the diorite nearest the contact is very dense, when only slightly removed, clearly porphyritic, and when entirely away from the contact is of medium to coarse in textures and more or less evenly granular. Where contacts cannot be found, the diorite in near proximity to the greenstone shows the phenomena just enumerated to a greater or less extent. Also, dikes of the diorite are found cutting the greenstone. This rock is not widely distributed through the Gold Hill district. A

line drawn from a point near the Peddler's Store nearly south, following closely, but lying to the west of Little Buffalo Creek, would mark its eastern boundary. Extending westward from this line, it occupies an irregular area varying in width from 1 to 3 miles. It is typically exposed in many places in the valley sides and stream beds in the Beaver Hills, especially near Barringer's Mill on Big Buffalo Creek and along the ridge tops southeast of Five Pines.

The Diorite.—This rock comes next in point of age and is, as has just been stated, intrusive into the greenstone. It varies greatly in character, both as to composition and texture. Sometimes it carries more or less quartz and becomes almost a typical "grano-diorite." Again it is found to be practically free from quartz and would be called a typical diorite. The texture varies from finely granular to very coarse. At times the feldspars predominate over the ferro-magnesian constituents of the rock; at others the reverse is true, and again they may be evenly balanced. It seems that there is a tendency on the part of the finer grained variations of this rock to be quartz-bearing. There is, however, no gradation into a granite, the nearest approach being the quartz-bearing diorite. In such an area as this one might expect a magmatic differentiation that would show gradations of the granite and diorite into each other, each being a differentiate from the same magma. This is not true in the case at hand, the granite and diorite wherever they come in contact with each other always having sharp and distinct boundaries. It is believed, however, that there has been more or less differentiation on the part of the diorite magma, and that this accounts for the local variations met with.

Although this rock occupies nearly half the igneous portion of the area, it is by no means well exposed at the surface, the exposures being limited to boulders and to little areas on valley sides and in stream beds. It does not resist weathering very well and is generally deeply buried in its own decay. Probably the best and most typical exposures are those in the vicinity of St. Peter's Church and near Rothrock's Mill on Second Creek. Typical exposures and also variations of the rock type may be seen along the Beatties Ford wagon road near Lower Stone Church and in many places on Jennie Wolf Creek and Black Run.

The Granite.—The youngest of all the igneous rocks, except the dikes, is the granite. This rock is a fairly massive, generally a medium-grained, light-gray granite, sometimes having a slight pinkish tinge of color. There are two distinct phases of this rock, one as described above, a normal gray granite of medium grain; the other is an aplitic facies, very fine grained and carrying only a small amount of ferro-

magnesian minerals. This latter phase is limited in extent and is found in abundance in only one place—on the road leading from Lower Stone Church to Rockwell, about 1 mile north of where the road crosses Second Creek. It is possible that this exposure represents only a large dike, and consequently that this variation of the rock occurs only as dikes. Some strength is given to this hypothesis by the fact that many of the small granite dikes which are found in considerable abundance near the borders of the granite mass cannot be distinguished in a hand specimen from this rock. The main mass of the granite shows some irregularities in texture and varies from a rather coarse-grained rock in the vicinity of Tyack's Store to a medium fine-grained rock exposed in the railroad cuts near Rockwell.

The granite is the youngest rock in the district, and makes a contact against all other rocks with which it is found, except the slate formation lying to the east.

Although the granite occupies a considerable portion of the area, exposures of the rock are by no means plentiful. Probably the best exposure of a fresh granite occurs about 1 mile north of the Peddler's Store, where a small amount of the rock has been quarried for local use. Other exposures of the deeply weathered and sappy rock occur in the vicinity of Tyack's Store and along the Gold Hill-Salisbury road, a short distance northwest of Second Creek.

The Slates.—The rocks here included under the general term "slates" make up the entire eastern half of the area, and while having many local variations, seem clearly to represent a great sedimentary series of shales with which are interbedded volcanic flows, breccias and tuffs. At and near the western boundary of the series, that is, at and near the contact of the igneous rocks to the west, the slates are dipping steeply—about 80 degrees to the northwest. Along this line the rocks are highly schistose and show markedly the effects of intense dynamic metamorphism, and it is in these metamorphic rocks near the contact with the igneous rocks that the important ore deposits occur. As one proceeds toward the southeast the effects of this metamorphism are seen gradually to die out. The dip, while prevailing to the northwest, becomes flatter and even changes sometimes to the southeast and the series becomes more massive and shows clearly its sedimentary origin. In their fresh and massive condition the slates are dense bluish rocks, which have in many places well-defined bedding planes and laminations. The volcanic flows, breccias and tuffs which are interbedded with the slates apparently represent two types of lava—rhyolitic and andesitic. The former occurs in most typical development in Flat

Swamp Mountain, a short distance northwest of Bringle's Ferry, and the latter in the southwest portion of the area, especially in the long ridge which lies to the west of Little Bear Creek.

The slate series tends to form a low-lying, flat country, with low, well-rounded ridges which mark the location of the volcanic beds. The character of the ridges depends directly upon the nature of the material forming them. The rhyolitic flows and breccias of Flat Swamp Mountain form the most prominent topographic relief in the district, and the andesitic flows and breccias near Little Bear Creek are next in importance as ridge-makers. The normal slates form slopes and flat valleys.

These rocks form a very dense, light-colored and exceedingly lean soil, and consequently make the poorest and least valuable lands in the whole district.

Dikes.—Dikes are very numerous in all parts of the district and are of four or five distinct types, which, in order of age, are diorite, granite and quartz-porphyry, fine-grained dense diorite, gabbro and, finally, diabase. The older diorite dikes are not at all numerous, and are found only in the vicinity of Foil's Mill on Buffalo Creek, where they occur in the greenstone. The rock has suffered much alteration, but does not differ essentially from the fine-grained facies of the diorite.

Granite and quartz-porphyry dikes are numerous, especially near the contacts of the granite with the older rocks. They are of two general types—ordinary quartz-porphyry and a very fine-grained aplitic granite. They cut both the greenstone and the diorite, but were not found in the slate area. As a rock, these dikes are of little importance other than from a scientific standpoint. They are generally deeply weathered and their location is determined only as light-colored bands cutting the dark-colored country soil. The second series of diorite-like dikes differ from the massive diorite of the area only in that they are made up of exceedingly fine-grained material and in that they occur cutting the granite dikes and the massive diorite. These dikes have not been able to resist weathering as well as the rocks which they cut, and consequently are recognized only as narrow bluish bands in the decay of the other rocks. One rarely finds even fresh boulders of these dikes, and when found they are small and deeply imbedded in the decay of the dikes.

Next in order come the gabbro and diabase dikes, the former being rare. The diabase dikes are numerous and are found cutting all the other rocks of the district. They are represented on the surface by numerous well-rounded black boulders, known locally as "nigger heads," which are confined to narrow strips that may extend laterally for a considerable distance.

GOLD HILL & VICINITY

SHOWING THE LOCATION OF MINES, PROSPECTS AND VEINS

Mines - X

Prospects - *

Veins - —

Quartz Veins - —

Strike and Dip of Strata - ↗

Scale - 1:12000

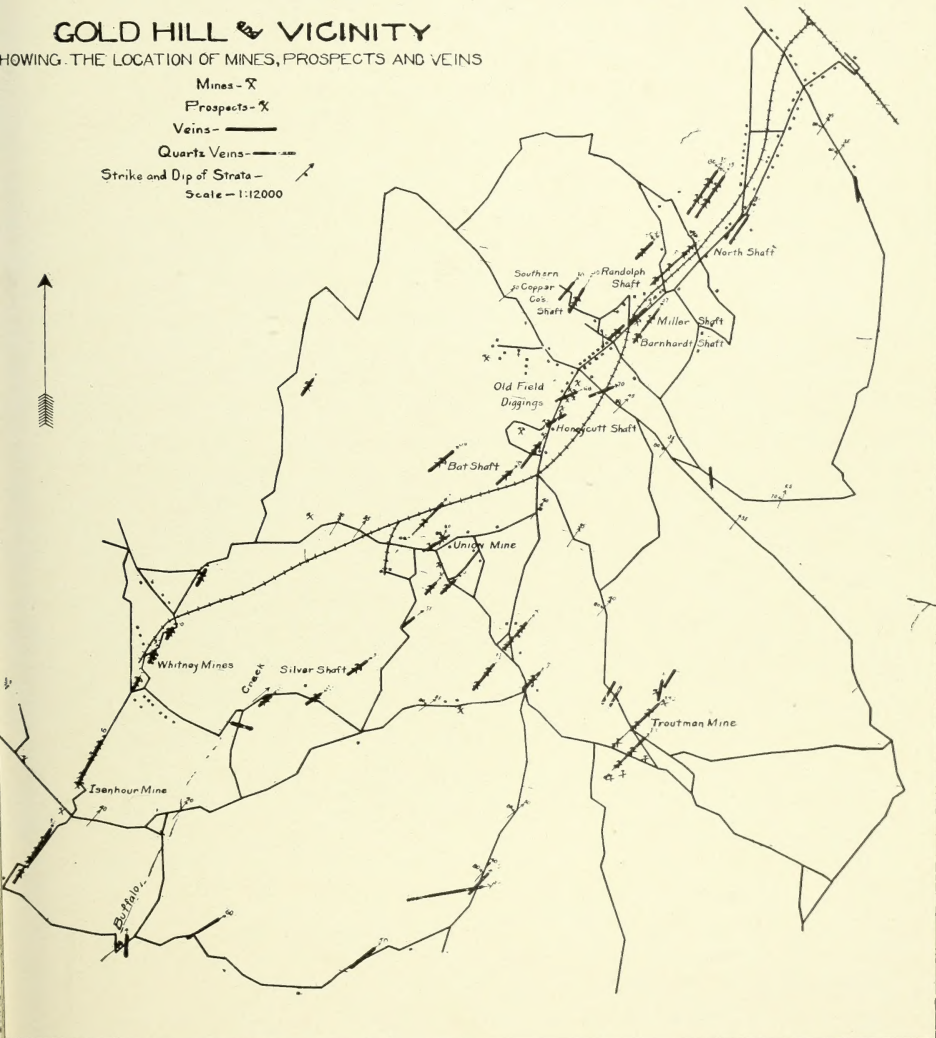


FIG. 2—MAP OF THE GOLD HILL COPPER DISTRICT, SHOWING LOCATION OF COPPER MINES, VEINS AND PROSPECTS.

At times this rock is decidedly porphyritic, the feldspars being large and numerous, forming a rock that may be called "labradorite porphyrite." This porphyritic rock occurs in considerable abundance along the county-line wagon road, about 1 mile northwest of the Whitney Company's mine. It also occurs along the Gold Hill-Salisbury road about $\frac{1}{4}$ mile southeast from the Peddler's Store. It is known locally as "spotted rock." Typical diabase dikes are found cutting all the other rocks of the area and appear to be especially numerous in the mining district, each mine showing up one or more of them. They are probably more numerous in near proximity to the granite-slate contact.

The gabbro dikes are found in both the slate and the diorite formation is limited, but many of them are of large size. In the slates they contemporaneous. Those in the slates are completely saussuritized, while those in the diorite are fresh. Their distribution in each formation is limited, but many of them are of large size. In the slates they are well exposed near Corinth Church. In the diorite they occur near St. Peter's Church and in the vicinity of the Cline Mine. A large gabbro dike is found at the Dutch Creek mines.

In trend all the dikes are dependent upon the structure of the region and invariably follow one or other of the numerous joint systems.

Structure.—The structure of the Gold Hill district, broadly speaking, is simple. It consists of a series of slates interleaved with which are bands of rather acid andesitic tuffs and small flows of the andesite and rhyolite, this series being separated by a fault of undetermined throw from the igneous rocks which make up the northwestern portion of the district. The slate area presents no important or complex structural phenomena. The formation has been jointed and thrown into minor folds with a prevailing northwest dip which varies from horizontal to almost vertical in the immediate locality of the Gold Hill fault zone. In this fault zone the rocks have been to a considerable extent altered into schists. Jointing and minor folding are well shown, but, with the exception of the one great fault and the zone of minor faulting at and near to the contact with the plutonic rocks to the northwest, there is nothing of much structural importance. The greenstone, diorite and granite areas present only the usual phenomena of such rocks. All the igneous rocks are closely jointed and the older formations show more clearly the effects of metamorphism than the younger rocks.

Folding.—The slate series within the district, with the exception of the portion in the immediate vicinity of the western contact, has suffered comparatively little dynamic metamorphism. The series as a whole has been thrown into large folds upon which have been imposed many minor folds, and with the development of which there have been

connected more or less faulting and more buckling in the immediate proximity to the main fault lines. Near the faults the strata are vertical and show markedly the effects of pressure metamorphism. Between these areas the strata are thrown into minor folds with no steep dips, oftentimes being approximately horizontal. Thus it appears that instead of the slate series yielding as a whole and being thrown into a few broad folds, it yielded by fracture in certain places and by buckling in the intervening areas. It may be, however, that the series has yielded as a unit, having been thrown into a large anticlinorium upon which are imposed the faulting and the minor folding mentioned. Only a small portion of the whole slate formation is included within the limits of the map here presented; indeed, so small a portion that no general conclusions applicable to the series as a whole can be drawn. The two theories, therefore, are stated only as possibilities. Evidences from sources outside the area mapped seem to favor the latter view.

The portion of the slate series within the map shows these rocks dipping very steeply toward the northwest at and near the granite greenstone contact. This northwest dip continues for a distance of from 2 to 3 miles to the southeast, where a minor fold reverses the dip for a short distance. It, however, assumes its normal northwest dip and is dipping in this direction at varying degrees—20 to 60 on the extreme eastern limits of the map. The strike of the folding is nearly always to the northeast and varies from 15 to 60 degrees, averaging about 35 degrees.

Jointing.—One of the most noticeable features of the whole Piedmont Plateau is the great number of joints. These joints, while well distributed throughout the whole 360 degrees of the circle, show a decided preference for certain directions and are found, as it were, grouped around three main directions.

Out of a total of 141 measurements of joints scattered throughout the whole Piedmont region, it was found that they could be grouped roughly as follows:

Total number of joints with strike	N. 10°—80° E.	61
	N. 10°—70° W.	52
	N. — S.	18
	E. — W.	10

Similar measurements of the trend of basic dikes in the same region gave the following group:

Total number of dikes with strike	N. 10°—50° W.	20
	N. 20°—40° E.	21
	N. — S.	6
	E. — W.	1

Thus, while there is a slight majority of the joints with a northeast strike, the dikes are about equally divided between the northeast and the northwest quadrants. East and west, and north and south trending joints and dikes are rare. In the above observations no attention was given to the dip of the joint planes.

Close attention was given to jointing in the Gold Hill district, both as to trend and dip of the joint planes. The results are in every way similar to those in other portions of the Piedmont Plateau.

In the slate formation there are not so many joints with the northeast trend as in other portions of the district, the reason for this being, perhaps, the ability of the joint-producing force to relieve itself along the northeast trending planes of parting in the slates.

Faulting.—Numerous insignificant dislocations are met with in nearly all portions of the district in which any prospecting has been done. These never, as far as noted, amount to more than a few feet, and are probably only the minor adjustments due to the faulting of the region, and are therefore of no great importance. In the mine workings, especially those of the Union Mine, there are a few offsets in the vein due to faulting; but from as close observation as it was possible to make upon these specific instances, it is believed that, while the fractures are true faults, they occurred prior to the mineralization.

There is believed to be one fault of considerable magnitude in the district, and this, together with the system of minor faults developed contemporaneously, has not only an important effect upon the ore deposits but also a most important bearing upon the principal relations of the different formations to each other and upon the physiography of the district. This is the Gold Hill fault which marks the western contact of the slate formation. It is only after a very close and detailed study of this contact, and after every other theory to account for conditions as they exist had failed, that the fault is admitted.

This fault zone extends through the entire district, with an approximate trend of N. 15° E., entering from the southwest near the confluence of the two Buffalo creeks and passing out about $\frac{1}{4}$ mile northwest from the mouth of Second Creek. A straight line drawn between these two points would approximately mark the contact of the slate formation on the east with the greenstone and the granite on the west. This line would very nearly mark the courses of Little Buffalo Creek flowing southwest, and Reedy Branch flowing northeast. (Fig. 3.) Both streams lie a short distance to the east of the line of contact, but flow approximately parallel with it. In no place was the actual contact between the formations visible, everything at and in the near proximity of this fault

line being deeply covered with the residual rock decay. Hence, it is only upon secondary evidence that the existence of this fault is deduced. These will now be stated and discussed.

1. The relation of the slate to the granite and the greenstone.

2. The absence of metamorphism in the slate series at the granite contact, and also the absence of a contact zone in the granite against the slates.

3. The absence of granite and aplitic dikes near and at the contact like those found in the diorite and greenstone near their contacts with the granite. Not a single dike of such description was found, although a very close examination of the territory near the contact was made.

4. Actual faults in the mines with strike apparently parallel with this main fault line, these lines of faulting clearly cutting the schistosity of the slates.

5. The very prominently developed system of joints with the trend approximately parallel with this assumed fault line, many of which have slickensided surfaces.

6. The fact that within the district the streams in the territory near this line follow it and not the schistosity as they do farther away from this line. If there had been faulting attended by the formation of a zone of brecciation, this zone must necessarily be more easily eroded than the unbroken slates. The streams would consequently find favorable ground along this line in which to work. In the territory more remote from this line the stream courses are controlled by the hard and soft layers in the slates, and conform to the strike of the schistosity. Reedy Branch and Little Buffalo Creek, which follow this line of contact, flow across the schistosity at a very acute angle and entirely regardless of hard and soft beds, making only slight curves around the more resistant portions, but no bends of any importance.

7. The relation of the streams to this line when it is produced beyond the district in both directions. The sketch map (Fig. 3) is taken from a map of North Carolina published in 1892 by the North Carolina Geological Survey. An examination of this map will show that there have probably been some exceptional causes for the approximately straight line of Abbott's Creek, Reedy Branch, the two Buffalo creeks and Rocky River. These stream courses form a line at least 75 miles in length, and this line is seen to be simply an extension of the line of contact between the slates of the granite and greenstone. It seems strange that Abbott's Creek should have a course cutting the schistosity of the slates at an acute angle when the other streams follow it, unless there had been some exceptional cause, something that would afford easier ground in which to work. From a hasty examination of the

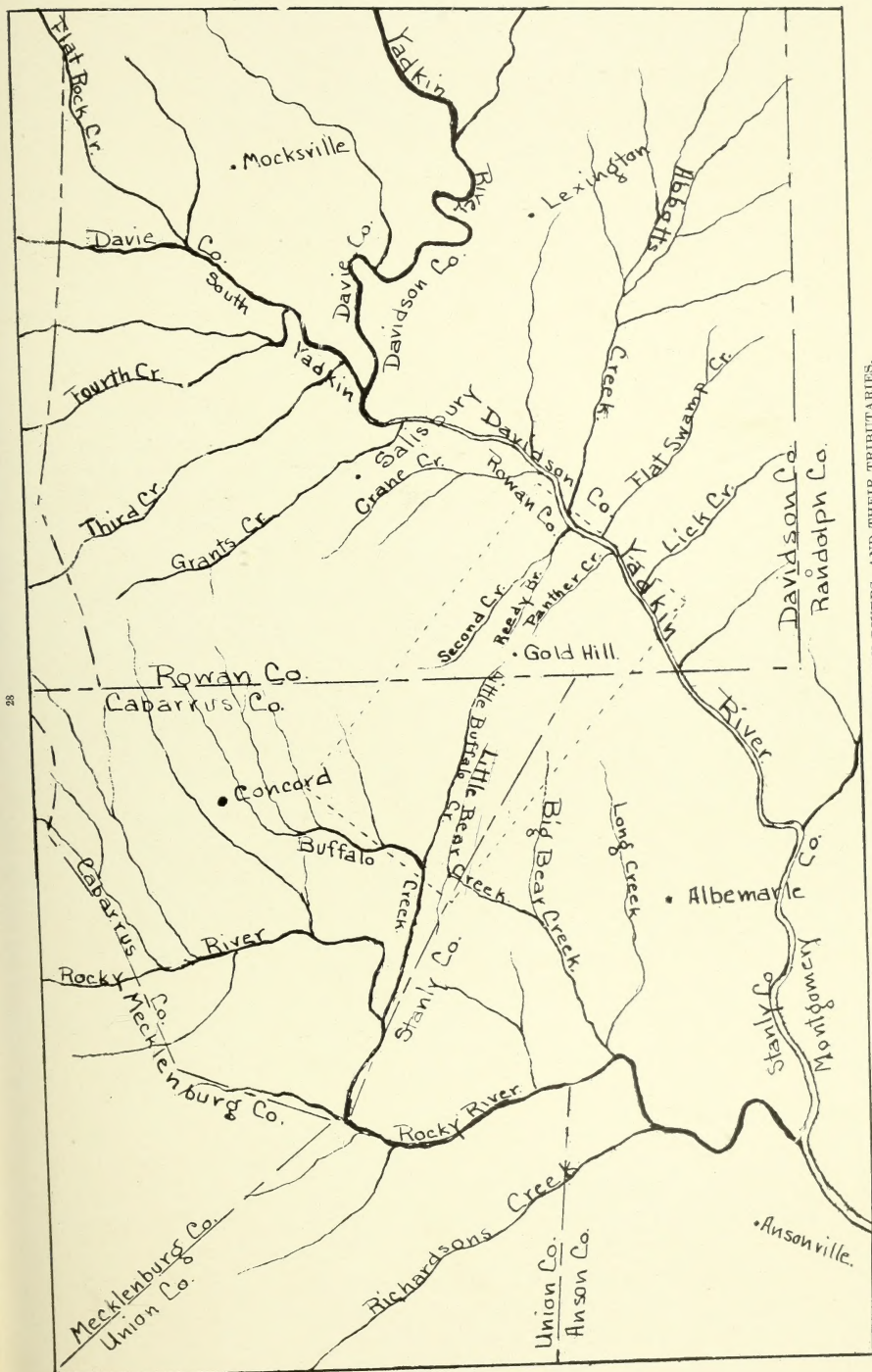


FIG. 3—MAP OF THE YADKIN AND ROCKY RIVERS, AND THEIR TRIBUTARIES.

country contiguous to Abbott's Creek, no such reason, unless it be faulting, is believed to exist. It also appears as if some similar cause may be responsible for the peculiar form of Buffalo Creek and Rocky River. It seems possible that these streams may represent cases of stream capture, that possibly at one time Buffalo Creek reached Rocky River through the channel now occupied by Bear Creek and at this time made its way to the Yadkin by a roughly parallel course now followed by the small stream south of Bear Creek and just east of the elbow in Rocky River. Given these streams in this relation and a smaller tributary working headward along the soft and easily eroded material that would be produced in a fault zone, and the phenomena now presented upon the map would be the normal result.

8. The line of contact throughout its entire length is marked by numerous springs, while the region remote from it is not well supplied with them, nor is the granite diorite contact marked by such an abundance of springs.

9. The continuous mineralization along and near this line of contact and its extension is regarded as having some weight in favor of the assumption of such a fault. By reference to the sketch-map it will be seen that the greater part of the mines in this part of the State lie close to the line formed by the extension of this line of contact. The majority of the ore deposits of these mines are described as fissure veins, either of mineralized quartz or as stringers of ore in fractured or splintered slate, and they furthermore are described as having a strike somewhat east of north. This is known to be the case with the group of mines at Gold Hill. It is not understood how a mere local cause could result in the formation of fissures along the line something like 50 miles in length; neither is it understood how such extensive mineralization could have taken place along a line of such great length simply as the result of local causes.

It is realized that the facts above presented do not prove conclusively that such a fault zone exists, but the evidence is believed to be strong enough to warrant such an assumption. Hence, it is believed that such a fault zone does mark the contact between the slate series and the igneous rocks lying to the northwest. It is not possible to say definitely which is the downthrow and which is the upthrow side of this fault. From observations as to hade of the fault planes in the minor parallel faults in the mines and the appearance of the slickensided walls in such faults, it is believed that the northwest side represents the upthrow.

THE ORES AND MINES OF THE GOLD HILL DISTRICT.

Historical.—The earliest mining within the Gold Hill district was for gold, but as the mine workings increased in depth the sulphide ores were reached, and these were found to carry copper as well as gold. These two metals, with which occur a little silver, are the objects sought for by the miners of the present day.

Gold was first discovered within this district at the Barringer Mine prior to 1824,* but the country lying to the southwest and southeast had been the seat of gold mining since the beginning of the century. This mining took its beginning at the Reed Mine, which lies only a few miles from the southwest limit of the area shown on the map. The first authenticated discovery† of gold in North Carolina occurred at this mine in 1799, when a nugget weighing $3\frac{1}{2}$ pounds avoirdupois was picked up in the bed of Meadow Creek on the plantation of Joel Reed. Further search resulted in finding a number of large nuggets, the largest of which weighed 28 pounds avoirdupois. The whole number of large nuggets discovered at this mine between the above date and 1834 was 14 and represented a weight of $115\frac{1}{2}$ pounds avoirdupois.

With the discoveries at the Reed Mine, active prospecting began and spread throughout the whole surrounding country, confined for the most part to the "slate area," which was found to be the most promising. Indeed, at a very early date in the century the slate formation was known as the "gold country." Denison Olmstead,‡ writing in 1824, says: "They [the gold mines] are situated in the southern part of the State, not far from the borders of South Carolina and somewhat west of the center. Through the 'Gold Country' flows the river Pedee [Yadkin], receiving within the same district two considerable streams, namely, Rocky River from the south and Uwahree River from the north * * The 'Gold Country' is spread over a space of not less than 1,000 miles * * * From a point taken 8 miles west by south of the Uwahree, with a radius of 18 miles, describe a circle—it will include most of the county of Montgomery, the northern part of Anson, the northeastern corner of Mecklenburg, Cabarrus as far as a little west of Concord, and the corners of Rowan, Davidson and Randolph * * * In almost any part of this region gold in greater or less abundance may be found at or near the surface of the ground." The area just described includes all the Gold Hill district. The principal gold-bearing veins, those at Gold Hill, were not discovered until 1842. Outcroppings of these veins were not prominent, and it is said that they were discovered by accident.

*A Report on the Geology of North Carolina. Denison Olmstead, p. 34, Raleigh, 1824.

†Historical Sketches of North Carolina from 1584 to 1851. John Hill Wheeler, New York, 1851. Vol. 2, p. 64.

‡A Report on the Geology of North Carolina. Denison Olmstead, p. 33, Raleigh, 1824.

Between the date of discovery and the beginning of the Civil War, mining was carried on at Gold Hill with considerable profit, and the place became widely known as a mining center, producing in this time, it is said, something like three million dollars.

At the beginning of the Civil War, the main shaft, the Randolph, was down to a depth of 700 feet, and the richer portions of the vein for about 1,500 feet were worked out to a depth of about 350 feet. The upper or oxidized portions of the vein were found to be very rich and the gold was easily extracted, amalgamating, it is said, very easily. The methods used in concentration were crude. The ore was first ground in an *arasta*, a kind of Chilian mill, made of two large granite "runners" and a large granite "bed." The mill was operated by horse power. The ore, after being run through this mill, was washed through a system of wooden rockers.

During this period of active mining quite a number of smaller mines and prospects were opened up at considerable profit. Among these are the McMackin (now known as the Whitney Mines), the Troutman, the Barnhardt, the Honeycutt, and the Old Field mines. The McMackin, the Troutman and the Honeycutt mines are said to have paid well until the upper portions of the veins were worked out. In these cases, as at the Gold Hill Mines, the operators were unable to handle the ores satisfactorily when the depth of mining increased and the unaltered sulphides began to come in. Their methods of concentration were too crude for ores that did not amalgamate easily. The copper of the sulphide ores, of course, could not be saved by such processes, and in general no attention was paid to it.

Until the discovery of the gold-bearing vein *in situ* at the Barringer Mine about 1824, all the gold mined was obtained from small placer workings in the stream beds and valleys. The methods of work were most primitive, sluice boxes and log rockers. With the discovery of the gold-bearing veins came the introduction of the Chilian mills, or gold grinders, as they were called, and these were still in use when the Civil War caused a cessation of all mining.

The mines were not opened up again until some years after the close of the Civil War. When the work was resumed, better and more extensive machinery was installed, and attempts were made to save both gold and copper, but with indifferent success. It seems that the operators, very soon after the reopening of the mines, began to use them as speculating properties, and while considerable legitimate and *bona fide* mining was carried on, it seems that the principal object was one of stock manipulation.

Geology of the Mines and Prospects.—Four mines and numerous prospects called mines represent the workings in the Gold Hill district. They are for the most part confined to the western edge of the slate formation and apparently to the immediate zone of the Gold Hill fault. The important openings, the Gold Hill Mine, owned by the Gold Hill Copper Company; the Union Mine, owned by the Union Copper Company; the Whitney Mines, owned by the Whitney Reduction Company, and the Southern Copper and Gold Mining Company's openings, together with numerous diggings and prospects, make up the Gold Hill mines. Of these the first two and the last one are located upon the Gold Hill Ridge, the Gold Hill Mine in the village of Gold Hill, the Union about $\frac{3}{4}$ of a mile southwest of the village, and the Southern Copper and Gold Company's shaft, located a few hundred yards west of the Randolph shaft. The Whitney Mines lie to the west of Buffalo Creek and, while not in the Gold Hill Ridge, are in the same fault zone and on the same side of the main fault line. Of these, the Gold Hill Mine, the Union Mine and the Southern Copper and Gold Mining Company's mines were in operation in 1907. (See Fig. 2.)

If a line be drawn through the Gold Hill and Whitney mines and produced to the southwest limits of the district, it will run roughly parallel with the Gold Hill fault line, crossing it just west of St. Steven's Church, where it passes into the greenstone. This line will be marked throughout its length by more or less prospecting and other evidences of mineralization. The principal prospects that have been opened in this portion of the district, the greenstone area, are the Kluttz, Harkey and Hopkins diggings.

Lying about $1\frac{3}{4}$ miles northwest of the Hopkins Mine is another group of prospects known as the Cline Mine and the Dan Hopkins diggings. The last of these is located in the diorite and the former in the greenstone very near the diorite contact.

The fourth and last group of prospects of the district is located near Garfield Post Office (Tyack's Store) and consists of two groups, one in the granite to the east of Second Creek, and the other to the west of the creek and in the diorite very near the granite contact. These are known as the Dutch Creek and the Gold Knob mines, respectively.

Types of Deposits.—These four groups of mines and prospects represent four classes or types of deposits. They may for convenience of description be designated as follows:

1. The Gold Hill types. In this the ores consist of auriferous pyrite and chalcopyrite in a more or less quartzose gangue, or as narrow stringers in rifts in the schists with little or no gangue material. The Gold Hill Mine and the Union are good examples of this type.

2. The Greenstone type. In this type of deposit the ores consist of slightly auriferous bornite and chalcocite in a gangue of quartz and epidote, very little or no chalcopyrite being present. This is exactly similar to the ores of the Virgilina district which Mr. W. H. Weed* has described as the Virgilina Type of southern copper deposits.

3. The Cline type. In this the ores consist of auriferous pyrite and chalcopyrite in a well formed quartz vein with a gangue of quartz, hematite, siderite and calcite. The Cline Mine and the Dan Hopkins diggings are the examples of this type. This type of vein and gangue minerals are very characteristic of the old Conrad Hill Mine†, which is located northeast of the Yadkin River in Davidson County, on the continuation of the Gold Hill fault line.

4. The Dutch Creek type. In this type the ores consist of auriferous pyrite and a small amount of chalcopyrite in a quartz gangue, the vein being located in the granite. The Dutch Creek Mines are examples of this type.

The Gold Hill type. This type of deposit includes two classes of veins, one consisting of stringers of ore filling narrow spaces between thin layers of the schist and presenting little or no evidence of silicification; in the other class the veins are larger, are highly silicified and show that more or less silicification of the country rock has taken place. The former are largely copper-bearing, the ore for the most part consisting of chalcopyrite in a gangue of pyrite, and carries very little gold. The latter carries, as a rule, only a small amount of chalcopyrite and is largely made up of auriferous pyrite in a more or less quartzose gangue. There are exceptions to these statements, but, in general, ores that carry high values in gold carry only a small amount of copper, while those high in copper are very low in gold. Both classes of veins have been developed along fractures in the country rock which may or may not run parallel with the schistosity. There is, however, as a rule, a general conformity between the strike of the veins and that of the country rock.

The schists at the mines have a strike varying from N. 30° E. to N. 45° E. and dip about 80° to the northwest. The outcrops of the veins are obscure and it is next to impossible to trace them upon the surface. The usual outcrop consists of only a narrow band in the schists which stands up a little more prominently than the surrounding rock, and which generally shows a more decided staining due to

*Types of Copper Deposits in the Southern United States. W. H. Weed, Trans. Am. Inst., Min. Eng., Vol. 30 (1900); 449-504.

†Metallic Wealth of the United States. J. D. Whitney, p. 130. Geology of the Midland Counties of North Carolina. Ebenezer Emmons, pp. 143-154.

the oxidation of the iron. Where the vein is quartz, this mineral marks the trend of the vein by its fragments. The largest and richest veins, however, are not quartz veins, being only more or less highly silicified bands or stringers in the schists.

The first type of vein varies greatly in degree of silicification at times, and even the walls are so highly silicified that they resemble chert and the ores are distributed irregularly through this highly silicious ground mass. At other times there is only a relatively small degree of silicification and the rock walls have suffered little or no alteration. This type of vein usually has well defined walls which frequently present slickensided surfaces.

The second type of vein consists to a great extent of a number of narrow stringers or bands of ore filling closely spaced openings or rifts in the country rock parallel with its schistosity, and presents a minimum amount of silicification.

True quartz veins in the vicinity of Gold Hill are not numerous, and are always narrow and lean or wholly barren. All the veins in a general way follow the dip and strike of the schistosity, but do not follow either continuously and are seen to follow one plane of foliation for a short distance and then break across to another. On studying a plan and elevation of this formation it is seen that the trend of the vein as a whole is not quite so strongly to the east as that of the schists, and that they really do cut the schists at low angles. The vertical sketch shows that the veins may have a steeper vertical dip than the schists, though at times the offset occurs in the other direction, thus giving the vein a flatter dip than the schists. An excellent example of this relation of the vein to the country rock is seen in the north vein of the 800-foot level of the Gold Hill Mine, which vein was being worked in 1907. A sketch, made from an actual survey of this level of the mine, showed very well the great number of small veins or stringers of ore, not less than eight in number, associated with three workable veins within a distance of 800 feet. The smaller veins, while sometimes high in values in either gold or copper, are always too small to work. They present the same features as regards vein matter and ores, and have the same relations to the country rock as do the larger veins. That is, they may follow either the schistosity or one of the numerous lines of fracture, or both schistosity and fracture, crossing from one plane of schistosity to another, following the line of fracture leading across them.

That the veins follow fractures in the schists is evident from the nature of the vein contents, their relations to the country rock and the very prominent slickensides which are developed upon the wall rock in

many places. The veins in many instances are seen to contain numerous angular fragments of hard silicified rock not unlike many of the bands of dense schist. That is, they show evidences of more or less brecciation. In other instances, the vein instead of being a breccia is made up of numerous stringers of ore filling narrow spaces between shreds of the schist, appearing as though the schists had been torn apart, and suggesting somewhat a fracture in a piece of tough wood in which the main fracture consists of many small fractures with splinters extending between them from wall to wall. Sometimes these breccias and stringers show that considerable replacement has taken place since their formation, they being more or less replaced by quartz and ore. In other instances they are approximately fresh.

The veins as well as the ore shoots within them have a well defined lenticular structure, sometimes attaining a width of from 5 to 15 feet and again gradually narrowing down to a width of only a few inches, or even pinching out entirely, leaving only slickensided walls in contact with each other. This lenticular structure is prominent in both longitudinal and vertical sketches of the vein. If the figure showing the relation of the vein to the country rock be examined, it will readily be seen how even a slight movement of either wall in any direction must necessarily tend to produce just such lenticular spaces as have been described. In addition to their lenticular character, the veins also possess other irregularities. Stringers of ore may lead off from the main vein and follow the planes of schistosity, and at times they are seen to follow one of the numerous joint systems.

It also appears probable that there has been very little fracture with appreciable dislocation since the deposition of the ores. It is true that in some instances the miners report slight dislocations in the veins, but it seems probable from observation in a few such instances in the Union Mine that such dislocations are for the most part due to an offset in the original fault line prior to the formation of the vein. It is also true that many joints and, in a few instances, diabase dikes are found cutting the veins. Every instance of a diabase dike in this relation in both the Union and Gold Hill mines was examined in detail, and in no case was there found any appreciable dislocation in the vein at the dikes. The vein in every instance in which the dike had been cut through was found to resume its regular trend on the other side of the dike. These dikes often run parallel with the veins, sometimes following one or the other wall for greater or less distance. In one instance, in the Barnhardt Mine, a dike was encountered which came up to the vein on one side, followed it for about 20 feet and then crossed it at nearly right angles and appeared in the other wall.

THE ORES.

The ores of the Gold Hill district are auriferous pyrite and chalcopyrite, with which is more or less gold-bearing quartz, quartz being the only gangue mineral of any importance. The gold values run higher in proportion as the copper values decrease; that is, the gold seems to occur with the pyrite to a greater extent than with the chalcopyrite. From detailed examinations of the respective "gold veins" and "copper veins" of the Gold Hill and Union mines, it seems probable that the copper and gold infiltrations are of two separate and, to a certain extent, distinct periods of mineralization, the one furnishing the copper with a small amount of gold and the other supplying the gold with a small percentage of copper, both of these being younger in age than the pyrite. It is believed by the operators that the "gold veins" are more highly quartzose than the "copper veins." With the pyrite and chalcopyrite also occur small amounts of sphalerite and galena, but in such small quantities that they are of no value. There is, however, one exception to this statement, the "silver shaft" of the Union Copper Company, which has produced considerable silver from an argentiferous galena.

The relation of Ores and Gangue.—The ores all contain more or less gold which will amalgamate readily, but there is also always a high value remaining in the concentrates, values representing from one-fourth to one-third the assay value of the ore. The gold in the quartz is known to be in free condition, as is also a part of the gold in the sulphides. Because of the high value of the concentrates, it has been assumed that at least a portion of the gold was present in chemical combination with the sulphur, or isomorphous with the iron and the sulphur. With the hope of determining the condition of the gold in the sulphides and also the relation of the sulphides to each other, a large number of specimens of typical sulphide ores rich in gold were selected for microscopic study.

Relation of the Sulphides.—The sulphides present in the sketches examined are pyrite, chalcopyrite, galena, sphalerite, bornite and chalcocite, the bornite and chalcocite not occurring with the other sulphides. The principal object sought by this study was the relation of the pyrite to the chalcopyrite, the ore being the so-called cupriferous pyrite, the especial object being to determine whether or not the ore consisted of a mechanical mixture of the two minerals, or whether it was really a copper-bearing pyrite. In every instance in which these two minerals occurred together it was evident that the ore consisted of a mechanical mixture of the pyrite and the chalcopyrite, each mineral

having its own definite boundary lines against the other, the pyrite being the older of the two. The order of deposition seems to have been first the pyrite and then a shattering of this mineral, followed by the introduction of the chalcopyrite, which is seen surrounding and filling in the spaces between the fragments of the pyrite crystals, often running out into knife-edged pieces in the minute cracks in the pyrite, the appearance being that of a breccia in which the fragments of pyrite were formerly imbedded in a matrix of chalcopyrite. Each mineral always had its own boundary lines clear-cut and sharp, there being absolutely no gradation of one into the other. Some of the pieces of chalcopyrite seem to have the form of pieces of pyrite, and it is possible that these may represent a replacement of the pyrite by chalcopyrite. Quartz was also present in the sections, but its definite relative age could not be determined. In part it appeared to be contemporaneous with the pyrite and in part contemporaneous with and later than the chalcopyrite.

When galena and sphalerite occurred, both seemed to be subsequent to the other sulphides, and of these two the sphalerite is subsequent to the galena. These minerals were only sparingly present in the sections examined.

Only a few sections of the bornite and chalcocite were examined. In every section of this ore examined the surface was seen to consist of a mass of bornite clearly distinguished by its peculiar bronze color through which was running a mesh or network of bright glistening lines of chalcocite, the amount of the respective minerals varying greatly. If the section appeared to be largely chalcocite, the lines of the network of this mineral were broader and many irregular areas of it occurred. If, on the other hand, the bornite were present in greater amount, the lines of the network of chalcocite were narrower and fewer in number, and there were only a few of the irregular areas just mentioned. The bornite did not as a rule present very clear-cut boundary lines against the chalcocite. No very positive statements can be made as to the relative age of the two minerals, but the appearance of each mineral and their relations to each other seem to suggest that the chalcocite may be secondary to and derived from the bornite.

RELATION OF GOLD TO SULPHIDES.

One of the principal objects of the microscopic examination of the ores was to determine, if possible, the condition of the gold in the sulphides. Many of the sections were from lean ore and no gold could be seen in them, even when careful panning would show its presence;

but in the majority of the sections, especially of the richer ores, it was not difficult to detect. The ores used in making the sections showed assay values running from \$5 to as high as \$375 per ton.

In every section in which gold could be distinguished in the sulphides (it occurred in the quartz also, but little attention was given to this), it had its own distinct and clear-cut boundaries and was clearly subsequent to the sulphide in which it occurred. Its manner of occurrence was not essentially different from that of the chalcopyrite in the pyrite. It was seen filling irregular areas and cracks in the pyrite, frequently running out to the very extremity of a narrow knife-edged crack, at times filling two or more roughly parallel cracks with stringers running from one to the other, and often filling the most irregular areas in the pyrite. It was in no case distributed evenly through the sulphide, but seemed to be more or less concentrated in certain areas. In only a few doubtful instances was it seen in the chalcopyrite, but there was no difficulty in finding it in the pyrite. The pyrite in all the sections was examined with great care to ascertain if it presented any peculiarities of structure, form or color that might indicate a chemical union with the gold, but, with only one or two doubtful exceptions, were any such features detected. These appeared to consist of striped areas in the midst of a fair-sized grain of pyrite which had a slightly different luster and color from the other portions of the grain. These areas were always small and had irregular boundaries. Their nature could not be determined. While it is possible that they may represent some kind of a combination of gold with the sulphide, it is believed that they are due to irregularities resulting from grinding and polishing the section, or possibly due to tarnish.

When the gold occurred in connection with galena in the pyrite, there was always difficulty in determining the relative age of the gold and the galena; sometimes the evidence seemed to favor the idea that the galena was subsequent, while again the reverse seemed to be the case. The gold in such occurrences always had clear-cut and well-defined boundaries against the galena. From the few instances in which the two were seen in juxtaposition it is not possible to make any definite statement as to the relative ages. It is believed, however, that the galena is subsequent to the gold.

As to the condition of all the gold in the sulphides, the work thus far done will not warrant any definite statements, but it is believed that it occurs only as free gold and not in a chemical combination with the sulphide or as a sulphide itself. This statement seems to be favored by the fact that in every instance in which the metal was detected in the sulphide it was in the native condition, and also by the fact that the pyrite in which it occurred always had, with only doubtful excep-

tions, its usual physical characteristics. The fact that all the gold will not amalgamate may be urged against the above conclusion, and this has been given due consideration. There is one very strong reason why the values cannot all be extracted by amalgamation. This is the fact, well shown under the microscope, that the gold runs out into such minute cracks in the pyrite that it would be impossible to crush the ore finely enough for all the gold to come in contact with the mercury without sliming the whole mass. Microscopic examination of the gold panned out from the ores examined adds weight to this statement in that it shows the gold to occur in exceedingly thin scales and very small irregular particles. There is also opposed to the possible combination with the sulphides the well-known fact that iron or ferrous salts will immediately precipitate gold from its solutions.* It therefore seems that the evidence is strongly in favor of the belief that all the gold in the sulphides is present in its native form.

NATURE OF THE ORE BODIES.

It has been stated that the veins have a lenticular structure, as seen in both horizontal and vertical plan. All portions of the vein are not of equal richness, although throughout the entire lengths of the exposed veins there is more or less mineralization; but it is only in certain portions that the mineralization has been of sufficient magnitude to form workable ore bodies. These ore shoots, of course, lie within, or rather are simply the richer portions of the vein. They, however, present irregular outlines and have a decided pitch to the southwest. In extent they vary longitudinally from 20 to over 100 feet; vertically from 100 feet to the greatest depths of the mines, about 800 feet. The values are not uniform throughout these distances, and the shoot shows all the "pinches" and "swells" of the vein. Ore shoots are best shown up in the Gold Hill Mine, the workings of which seem to indicate three and possibly four shoots.

In the detailed examination of the ore shoots in this mine it was interesting to find that the slickensides on the walls of the veins were not vertical, but were inclined to the southwest at an angle approximating the pitch of the ore shoots. This and the shape and pitch of the ore shoots seem to indicate that the dislocation along the lines of faulting now marked by the vein had both a vertical and longitudinal component. The slickensides in the 300-foot level of the Barnhardt shaft showed a similar inclination, but the workings have not been extensive enough to indicate anything very definite as to the pitch of the ore shoots, two of which have been worked to a limited extent.

*A treatise on Metamorphism. C. R. Van Hise, Monograph 47, U. S. Geological Survey, p. 1091, et seq.

Relation of Ore and Gangue.—As has been stated above, there are two types of veins: one in which the ores occur as stringers in the schist, the other in which they occur with more or less quartz as gangue. In the first type the vein consists of numerous narrow stringers of ore which lie in the opened-up planes of schistosity of the rock and which are separated one from another by narrow bands of the schist. There is no gangue in such a vein, the ore occurring simply as a filling in the rifts in the slates, and the vein consisting of a group of these stringers of ore and schist. In this type of vein there has been little or no silicification of the immediate schists, and only a very limited deposition of quartz. The diagram (Fig. 4) is an attempt to illustrate this type of vein structure.

The other and prevalent type of vein differs from that described above in being more highly silicious, containing numerous mashed and drawn-out fragments of the country rock, and also much more white quartz. This vein is apt to be larger and more persistent than the other type, and it shows to a greater extent the evidence of the schists having been replaced by quartz, thus indicating possibly a more vigorous circulation. In this type of vein the ores may have a banding parallel with the schistosity of the rocks, the bands often spreading out and including elongated areas of the silicified schists, the ore following around these and other smaller fragments in graceful curves. In some instances it seems evident that areas of the broken schist have been replated by the ore. In the more highly quartzose portions of these veins the ore has an irregular distribution through bluish gray, quartzose ground mass. These ores usually carry their values in gold rather than in copper, while those of the first type have their values in copper, with only a small amount of gold. In each type the pyrite seems to have been the first sulphide to be deposited. Subsequently there came in, in one instance, considerable quantities of chalcopyrite which formed a kind of cement, as it were, filling the fractures and cracks in and around the pyrite. In the other there seems to have been very little chalcopyrite, but considerable gold, which was deposited in the manner described. The solutions which deposited the gold, especially in the Gold Hill Mine, seems to have been more highly charged with silica, and to have had a much more marked effect upon the materials of the vein. The veins rich in gold in this mine seem to be more highly silicious than those which carry copper and only a little gold.

MINES AND PROSPECTS OF THE GOLD HILL TYPE.

As typical examples of this type of deposit, the following may be mentioned: Mines and prospects belonging to the Gold Hill Copper Company, the mines and prospects belonging to the Union Copper

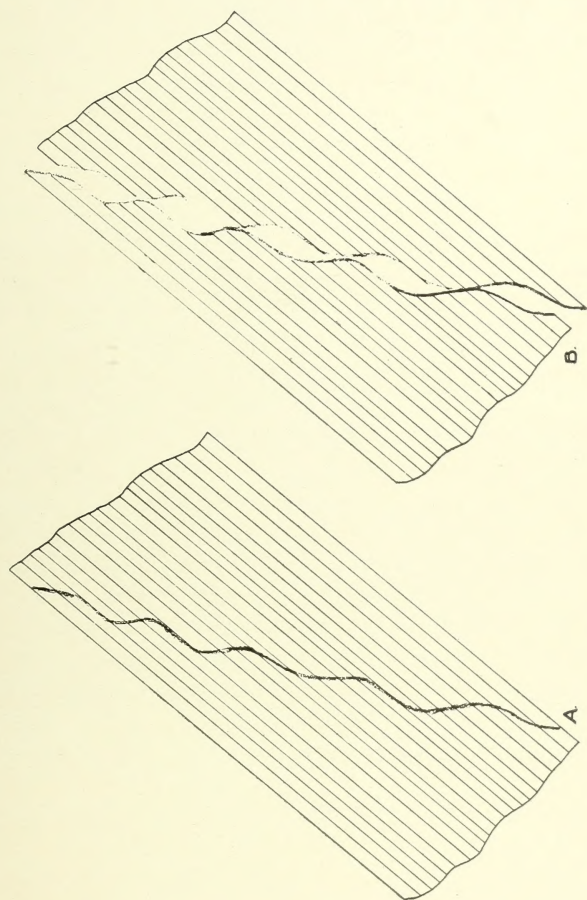


FIG. 4—DIAGRAM ILLUSTRATING OCCURRENCE OF COPPER VEINS IN SCHISTS, AT GOLD HILL. THE SCHISTS HAVE OFTEN BEEN DISTURBED, SO THAT THE RIFTS NOW HAVE THE APPEARANCE AS SHOWN IN B.

Company, the mines and prospects belonging to the Whitney Company, and those of the Southern Copper and Gold Mining Company. They will now be described somewhat in detail. (See Figs. 1 and 2.)

The mines and prospects of the Gold Hill Copper Company.—These consist of the Gold Hill Mine (Randolph shaft), the Miller and Barnhardt shafts and the Old Field diggings.

The Randolph is one of the deepest shafts in the South, reaching a depth of 820 feet, and the workings from it and from a line of caved and dilapidated shafts on the same vein immediately to the northeast have been more extensively stoped than any other mine in the State. From these shafts the workable ores of the largest vein in the mine (the Randolph), varying in width from 2 to 15 feet, have been removed from about 1,500 feet of the linear length of the vein to a depth of about 700 feet. In addition to this work there have been numerous exploratory drifts driven into the walls, thus showing both the location and pitch of the ore shoots, and, to a certain extent, the character of the wall rock. The ore shoots have been discussed in another place (p. 36) and will not be taken up here any further than to state that the ore in the upper levels—in the oxidized zone—was an exceedingly rich free-milling gold ore, and as depth increased the sulphides began to come in and the gold values greatly decreased. No records of the early workings were kept, and the depth of oxidation, etc., cannot be given. It appears, nevertheless, that the first sulphides encountered were fairly rich in gold and carried a low percentage of copper, from 2 per cent. to 10 per cent. Both values seemed to have decreased with depth as well as the width and extent of the ore shoot. At the present depth, 800 feet, the assays from this vein show from a trace to \$2 per ton in gold and from 1 per cent. to 3 per cent. of copper, the vein being narrow and unpromising.

The greatest amount of exploratory work has been done on the 800-foot level, about 2,000 feet of drifts having been driven both along the trend of the veins of the upper levels and across the schistosity of the country rock. This work has been mentioned and discussed to a limited extent in another place and also a sketch of the workings made from a recent survey, but it may be well to discuss it in greater detail at this point.

The drifting started at the shaft and was driven in two directions, approximately at right angles, to the schistosity of the country rock, to a distance of 440 feet to the south and 360 feet to the north, intersecting no less than eleven mineralized bands of greater or less importance. Three of these were of considerable size and drifts were driven along them for some distance. These three are the Randolph vein, which was

very rich in the upper levels of the mine; the Miller vein, which had been opened up by the Miller shaft in one place to a depth of 160 feet and by the Barnhardt shaft in another to a depth of 435 feet, and the new North vein, which was not known to exist prior to this work.

The small stringers are of no importance from an economic standpoint, but of interest in that they show that the Gold Hill ridge at this point is made up of a zone of mineralization, and that this has taken place in fractures and openings formed by faulting. The fact that some of these veins "run" with the strike of the schistosity, while others cross it at acute angles, shows that there was cross-fracturing as well as fracturing along the places of schistosity, which is believed to have been developed long before the faulting occurred.

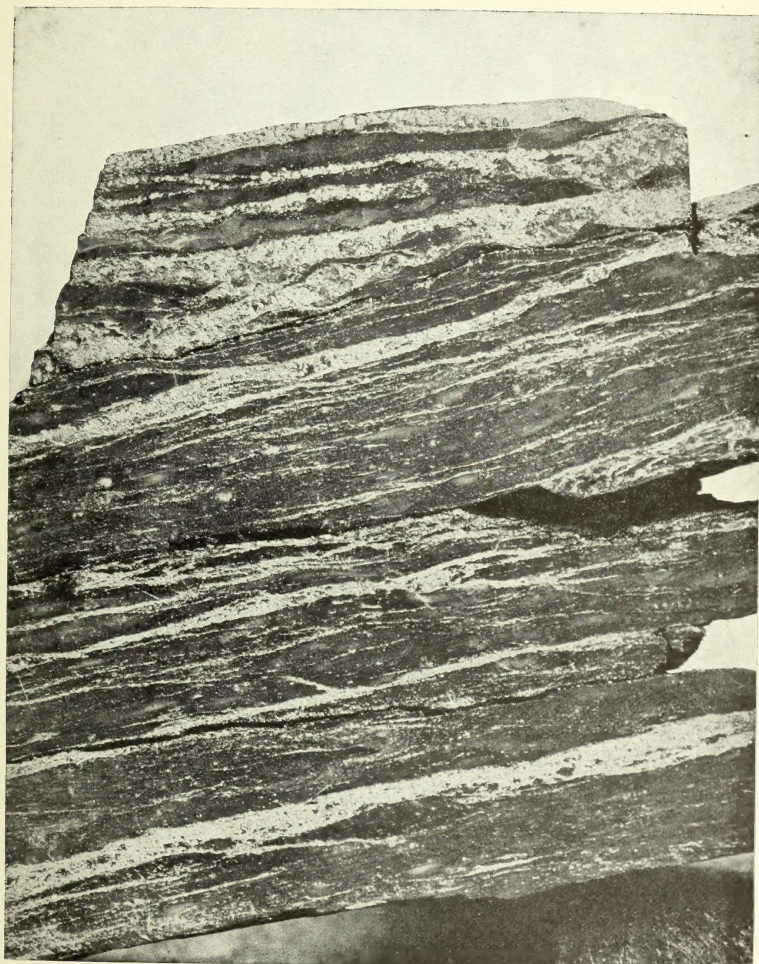
The work along the strike of the Randolph vein showed conclusively that the rich ore shoot of the upper workings did not extend to this depth. It also showed that the fracture along which the mineralization took place not only extended to this depth, but was mineralized, not, however, to the same extent as in the upper levels. Furthermore, it revealed a series of fault planes trending N. 30° W. which presented more or less brecciation, but no displacement of any moment.

The vein encountered at a distance of 440 feet south from the foot of the shaft is in all probability the same vein opened up by the Miller and Barnhardt shafts.

This vein has been exposed along its trend for a distance of about 150 feet. In character it is not essentially different from the vein in the Miller shaft and drifts, and in all probability is the same vein. Where it was first encountered, and still in the northeast end of the drift, it is narrow, but as work was continued westward along its trend, it was found to gradually increase in width until in the present southwest heading of the drift the vein has a width of about 12 feet. (By the word vein is meant that portion of the schists with which the ore is interleaved, and not that the body of ore is 12 feet in width. If all the ore now showing in the heading of the drift were concentrated into a single vein of solid ore, it would not have a width of more than 12 or 15 inches.) This amount of ore is simply interleaved with about 12 feet of rifted schist in the manner shown in Plate IV and constitutes the "vein."

Samples collected across the entire width of the vein in many places are reported to have shown a copper value of from 1.5 per cent to 5 per cent. with from a trace to \$2 per ton in gold.

This vein, while during part of its course is following the schistosity of the country rock, is as a whole apparently following a fracture trending about 15° or 20° east of north and approximately parallel with the North vein.



PHOTOGRAPH OF SMALL PORTION OF TYPICAL "SLATE VEIN," SHOWING ORE FILLING
CREVICES IN RIFTED SCHIST, MILLER VEIN, GOLD HILL MINE.

More interesting than these is the North vein, which does not outcrop at the surface and which was not known to exist prior to this work. This is a well-defined, mineralized and silicified band in the slates, as well defined as any vein in the district, and varies in width, vein matter and ore from 2 to 8 feet, averaging perhaps 3 feet. The ore was found to carry high gold values and very little copper, the gold running from \$10 to \$385 per ton, with less than 1 per cent of copper. Drifting was continued along the strike of the vein for considerable distance, and it was found that the rich portion was an ore shoot about 60 feet long, and also that the vein was following a fracture which cut the strike of the schistosity of the country rock at an acute angle, having a more northerly trend than the schistosity. A rise was made at the northeast boundary of the shoot and a winze was sunk at the southwest extremity, and these gave strong evidence that the shoot has about the same southwest pitch as those in the Randolph vein. The drifting along the vein encountered two diabase dikes, each about 10 feet wide, that cut it nearly at right angles, producing no displacement, and, as far as could be determined, had had no decided influence upon the values of the ore. Stringers of ore at one or two places were seen to be leaving the general trend of the vein and entering the walls in a direction parallel with the strike of the schistosity. These were not followed by the drifting. The ore from this vein is remarkably rich in free gold, the greater part of the gold being carried by the pyrite. The relation of the gold to the pyrite and other gangue minerals in this vein has been described in detail on page 37.

Some conclusions and surmises reached as a result of detailed study of the veins and ores in the mine, and of the ores in the laboratory, are summarized below.

1. That the rich ore shoot of the upper workings of the Randolph vein has pinched out.

2. That instead of there being one main vein well mineralized, there is a series of small and medium-sized veins irregularly distributed throughout the schists.

3. That there are clearly two types of veins: one highly silicious and somewhat quartzose and showing considerable replacement of the country rock by both silica and ore, the other presenting a series of narrow stringers of ore filling fissures which have been formed by splintering or tearing apart the schists along their planes of parting.

4. That the veins may be expected to extend to great depths, the Miller vein being as well developed at a depth of 800 feet as at the 160-foot level. The Randolph vein also persists and is well defined, only

having decreased in width and value. Assays made from both the 160 and the 800-foot levels of the Miller vein show similar values in both copper and gold.

5. That the veins relatively high in copper values will probably be low in gold, and that when high in gold they will probably be low in copper; that is, that some of the veins are predominantly copper-bearing, while others are predominantly auriferous. The Miller vein is predominantly chalcopyrite, while the North vein carries very little chalcopyrite, but high values in free gold in both the quartz and the pyrite. This has been discussed in detail on pages 36 and 42.

6. That the free gold in the pyrite in the North vein is not the result of secondary alterations by oxidizing waters, the pyrite being perfectly fresh and showing no trace whatever of secondary alterations. This depth—800 feet—is certainly 400 feet greater than the oxidized zone has reached in any other veins in the district. The gold, therefore, is believed to have been deposited in the pyrite originally as free gold, and to have been brought up from the unknown depths by the waters which produced the silicification of the country rock at the vein.

7. The fact that one vein is predominantly copper-bearing and another predominantly auriferous leads the investigator to suspect that there were two periods of mineralization, and if not two periods of mineralization, at least two sources for the mineralizing solutions.

8. The fact that the North vein with high gold value does not outcrop at the surface and has not been cut by the upper workings, suggests that there may be a large quantity of gold ore in the portion of the vein between this depth and the surface. The fact that the vein does not outcrop at the surface also leads to the belief that there is possibly a considerable future to mining in the Gold Hill district, and that systematic prospecting legitimately done is certainly warranted in many places in the courses of the veins that have been supposedly worked out at one place and which are known to have greater linear extension.

The Barnhardt and Miller shafts.—These shafts have already been discussed and there is little to be added. They are situated about 500 feet southeast of the Randolph shaft and are presumably on the same vein, but probably in two distinct ore shoots. The ores from each shaft are similar and occur in somewhat the same way. The vein is a "slate vein," that is, a mineralized and silicified band in the country rock, the vein rock differing from the country rock only in the degree of silicification. In some places in this vein there is little or no silicification, the vein consisting of the splintered and torn apart schists with the ore filling the spaces between the shreds or rock. The walls show

well-developed slickensides in many places and there are numerous little stringers of ore in the rocks near the main vein. These sometimes follow the schistosity, and at others follow fractures that cut it at an acute angle, having generally a trend more to the northward than the schistosity.

It is in this vein that the diabase dike mentioned on page 35 occurs. Careful examination of the ores in close proximity to the dike failed to show that it had had any apparent influence upon their character. The dike came up to the vein in the foot wall, followed it for a short distance, crossed it and then disappeared in the hanging wall.

The workings on the lower level of the Barnhardt shaft had not been extended far enough to give much information as to the character of the Miller ore shoot at the place where it was intersected by the drift. It is certain, however, that these two shafts are each in an ore shoot, and that the Barnhardt shoot pitches to the southwest approximately parallel to the *striae* on the slickensided walls of the vein, and it is believed that the Miller ore shoot has a similar pitch.

The "Old Field" Workings.—This group of prospects and shallow shafts lies a few hundred feet to the southwest of the Barnhardt shaft, apparently on the southwest continuation of the same mineralized zone. They were filled with water at the time of examination and were inaccessible. The work has extended only to water level, but it is said that a considerable quantity of free gold was obtained from them. No large and well-defined vein is reported, but only numerous narrow stringers of ore in a comparatively narrow space in the country rock.

The Gold Hill Copper Company is fairly well equipped for handling the ores. The shafts are in good repair and are furnished with good hoisting machinery. The general equipment consists of a mill with 40 stamps, amalgamating plates and Wilfley concentrators. They have a good boiler house and machine shop and dynamo and air compressor.

The Union Copper Company's Mines.—This company is operating two mines and has opened numerous prospects in the Gold Hill district. The mines in operation are the Union and the Old Honeycutt, now known as "No. 12."

The Union Mine, shaft No. 3, of the company, is, with the exception of the Gold Hill Mine, the most extensively developed in the State. The shaft has been sunk to a depth of about 600 feet and extensive workings have been made on five levels. One large lens or shoot of ore extending from the surface to the seventh level has been practically worked out. This ore body was an irregular lens-shaped mass over 100 feet long, possibly 50 feet in greatest width, and extended from

the surface down to the seventh level of the mine, about 500 feet. This ore body presented some rather suggestive irregularities of form, as may be seen by referring to the plan of the workings here given.

It will be seen that the open cut, the sub-level, the first and a portion of the second level, present an ore body with a trend which cuts the schistosity at a low angle, schistosity being about N. 40° E. while the trend of the ore body of these three levels is approximately N. 25° E. In the south end of the second level it will be seen that a portion of the ore body has a trend of nearly 65° E. of N. It will be seen that the third level presents an ore body with a trend approximately parallel with the strike of the schistosity, and, in addition, there is a small ore body near the north end of this level having a trend N. 35° W. A few feet south of this there is another small deposit of ore with a trend parallel with the schistosity.

It is clear from a detailed examination of all the underground workings that the ore bodies have been developed in a fault zone in which the hade and strike have been very irregular. It appears, therefore, that probably the vein, the open cut, the first and sub-levels and a portion of the second level is following a fracture roughly parallel with the strike of the Gold Hill fault, and that the abrupt turn in the trend of the ore body in the south end of this level is caused by the development of this portion of the ore body in a cross-break, a fracture extending across the schistosity and connecting the ore body as it is found on the third level where it follows the schistosity with that end of the third level which is clearly following a fault with a strike of about N. 35° W. This sketch also shows plainly that the ore shoot has a decided pitch to the southwest. It was interesting to note in this case, as in the Gold Hill Mine, that the strike of the slickensided walls were inclined strongly to the southwest, approximately parallel with the pitch of the ore shoot.

The small shoot of ore trending N. 35° W. was also encountered on the first level. The size and trend were the same as on the third level. This line, N. 35° W., is one of very prominent jointing throughout the whole district, often presenting slickensided walls and is very frequently followed by dikes. The Cline Mine and the Dan Hopkins digging are situated on well defined and well mineralized quartz veins, having a parallel trend in this direction. The subject of faulting has been discussed in detail (page 27). If the irregularities of these veins be compared with the sketch showing the general type of faulting for the district, it will be seen that this, together with the direction of movement indicated by the slickensides, will explain the irregularities here encountered.

The ore of this mine is a low-grade copper ore and consists of chalcopyrite with pyrite, a little sphalerite and some galena, the relation of the sulphides being the same as that at the Gold Hill Mine. (See page 36.) The ore always yields a small gold value, rarely over \$1 per ton, and is worked as copper ore. Panning shows that the greater part of the gold is present in the ore as native gold. The vein matter consists of fragments of silicified country rock, a small amount of secondary reddish-brown, semi-translucent quartz, together with much silicification of the adjoining schists. The ore occurs both in the quartz and in the altered schists. The average run of the vein is about $2\frac{1}{2}$ per cent. to 3 per cent. of copper, but the ore is "bunched" in the vein so that it may be raised to 8 to 10 per cent of copper by hand-cobbing.

The methods of mining used in working out the large ore body in the upper levels by means of square-set timbering has been described in detail in the report for 1907.*

The mine is fairly well equipped; the shaft and the machinery in general are in good repair. The company has no concentrating plant and the ore is all shipped after being hand-cobbed.

There are numerous old prospects on other mineralized bands or veins in the immediate vicinity of the Union Mine, but they had all been abandoned and were filled with water and hence inaccessible. Their location and the trend and character of the vein, as far as they could be determined, are indicated on the detailed map of Gold Hill (Fig. 2).

The Honeycutt shaft, now known as No. 12, is located a short distance west of the Old Field diggings and is apparently on the westward continuation of the same mineralized zone. This mine was opened in the early days of mining on Gold Hill, and is said to have produced considerable free-milling gold ore. Like the other veins of the district, as depth increased the sulphides were encountered and the work was abandoned. Another vein lying at about 100 feet northwest of the Honeycutt vein was also prospected in the early days, but it was found to carry principally copper and only a little gold. It is now being worked from shaft No. 7. The vein is narrow and unpromising, but is well defined and apparently follows the strike of the schistosity. It is interesting to find here a repetition of the conditions at the Gold Hill Mine, two veins close together, one carrying a gold value with little copper and the other with little or no gold.

The Whitney Company's Mines.—These mines were not in operation at the time the field work was in progress. They were therefore inaccessible and little can be said about them. Three shafts have been sunk,

*The Mining Industry in North Carolina During 1906, Economic Paper No. 14, N. C. Geological and Economic Survey. Joseph Hyde Pratt, p. 26, et seq.

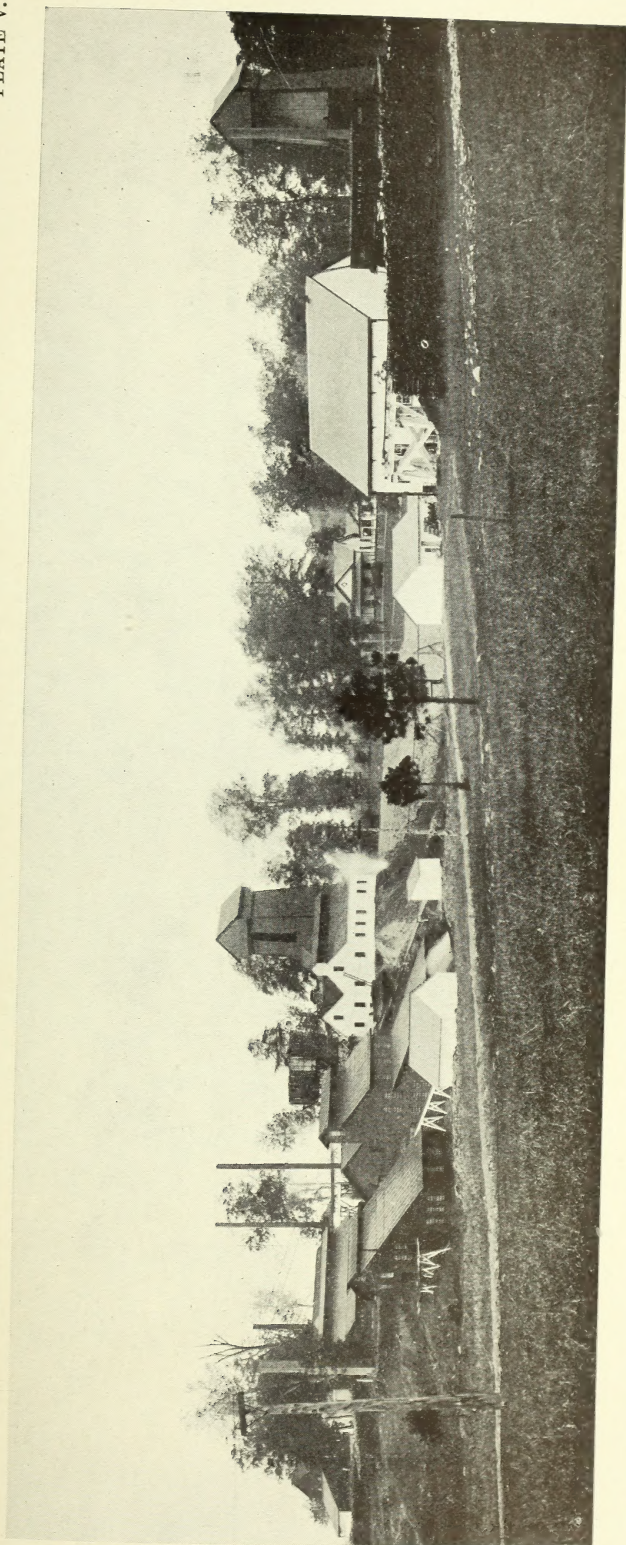
the deepest one to a depth of 700 feet. Much underground development has followed and it is reported that there are a million and a half tons of gold ore averaging about \$2.50 per ton now blocked out. (See Pl. V.)

They were formerly known as the McMackin and the Isenhour mines. They are located a short distance to the west of Little Dutch Buffalo Creek and on rather low ground, but clearly in the Gold Hill fault zone and only a short distance east of the greenstone contact, all the mines lying in the tuff area and not in the greenstone.

The vein, as far as could be determined, is the ordinary "slate vein"; that is, it consists of auriferous pyrite interleaved with the schists, the ore filling narrow spaces parallel with the schistosity—really the opened planes of schistosity of the rifted schists. In character and mode of formation it does not differ essentially from the Miller vein of the Gold Hill Mine, except that in the Whitney vein there appears to have been a concentration of gold rather than of chalcopyrite, as in the Miller vein. Judging from the material on the dump, both veins have been developed in precisely the same way, probably by the force of the crystallization of the pyrite in opening and widening spaces in the planes of schistosity as it was being deposited. Much of the gold seems to have been deposited in a similar manner, many specimens of the ore showing the thinnest films of gold—almost like gold leaf in the planes of schistosity of the rock. From accounts of the ores in the copper portions of the vein, it seems that a larger percentage of the gold occurred in this manner. The pyrite, which contains a small amount of chalcopyrite, also carries free gold, as all the concentrates show when panned.

This "vein" has an almost continuous outcrop for a distance of nearly two miles. Many little pits have been sunk in it in various places and each one is reported to have shown more or less gold, none of them showing very high values. As regards its length and continuity of outcrop, it is probably the strongest single "vein" in the Gold Hill district. (See sketch map, Fig. 2.)

From data and drawings furnished by the company, it appears that the values in the vein or ore shoot are very irregular. It was not possible at the time of the field work to examine the ore body, the mine being filled with water, but it appears from reports by the engineer in charge of the exploration and test work done at the mines, the late Mr. W. J. Parker, that the ore is concentrated in certain layers or "floors" in the vein delimited by joint planes. To state it in other words, it seems that the joint planes being favorable for circulating solutions, they have to a great extent controlled the concentration of the ores,



VIEW OF THE WHITNEY COMPANY'S MINE, GOLD HILL, ROWAN COUNTY, N. C.

especially the gold. In one report on file in the company's office, Mr. Parker says: "I have surveyed the 370-foot stope in the Whitney Mine and will send you a drawing of it in a few days. The ore shoot in this stope follows a so-called floor or slide, which is in reality a bedding or structural plane of the slates. These bedding planes all over the mine undulate considerably, but, taken as a whole, dip to the northeast. This individual flow is lying nearly flat in the stope, and for this reason goes over the top of the 370-foot north drift north of the rise. When within 30 feet (vertical depth) of the 260-foot level (in the rise), another bedding plane is encountered and above this there is but very little gold.

"It seems that all the better ore in this mine is confined to certain strata of the slate, and the reason that the ore is only 5 to 20 feet wide in these strata is because all the gold has been segregated to within that space."

When it is known that the schistosity of the slates (tuffs) corresponds to their bedding planes, a fact which Mr. Parker apparently did not recognize, it is quite evident that by "floor," "slide," "structural plane" and "bedding plane" he is referring to the numerous nearly horizontal joint planes which are so prominently developed in the vicinity of Gold Hill.

The ore in this vein, as in all others of the district, lies in fairly well defined shoots, the Air shaft being located in one and the Isenhour in another, but the amount of work thus far done is not sufficient to warrant any statements as to pitch and general character of these ore shoots. In regard to the width of the vein and value of the ores †Mr. Pratt and Mr. Steel say: "The vein varies from 3 to 4 feet wide to 25 feet, and Mr. E. B. C. Hambley, the manager of the Whitney Company, assumed an average of 14 feet. His engineer (W. J. Parker) reported a million and a half tons of ore blocked out. As the vein was more definitely proved to be of value, the prospecting shafts were sunk larger so that they can be easily changed to three compartment shafts and the mine equipped for an output of 1,000 tons a day. Part of the vein is very low grade, less than \$1 a ton, but this shows occasional rich spots and cannot well be left. In the more quartzose parts there are some rich shoots or lenses 50 to 100 feet across of as high grade as \$14 to \$16 per ton.

"During the development work ore from the various drifts and cross-cuts was tested in the old McMackin mill of 10 stamps with chlorination annex. Tests made of 4,950 tons gave per ton of ore: Free gold \$0.51

†The Mining Industry in North Carolina During 1906, Economic Paper No. 14, N. C. Geological Survey, 1907, p. 46.

to \$38.75, average \$4.52; gold in concentrates per ton of ore \$0.10 to \$0.83, average \$0.34; gold in tailings per ton of ore \$0.31 to \$2.75, average \$0.83. The ore yielded from 1.83 to 12.87 per cent. of concentrates which had an average value of only \$4.17 per ton. Chlorinating the concentrates gave an average gold recovery from them of \$3.33 per ton and a loss in the tailings of \$0.84. The amount of gold amalgamated was 79.44 per cent., while that recovered from the concentrates was only 4.78 per cent. of the total value of the ore. They will therefore not bother with concentration, but merely save as much gold as possible by amalgamation. Cyaniding has not been investigated as yet, but will hardly pay on tailings which will be so low grade.

"There was a special report for each mill test, naming the place from which the ore was taken and all details. By careful sampling in the mine, they have figured that the ore will give an average recovery of \$2.50 per ton, but in the same proportion as that tested. On the basis of 1,000 tons per day, Mr. Parker expected to mine the ore for \$1.03 per ton, transport it to the mill for 12 cents and mill it for 26 cents, total expense, \$1.42 per ton, showing an expected profit of a little over \$1 per ton. Of course, this involves equipment for electric hoist and haulage plant, etc. They will use double-deck cages, since the slaty ore is expected to give trouble in loading skips. It was Mr. Hambley's intention to push the development work only fast enough to keep a half million tons of ore blocked out. He states that the vein can be followed on the surface for a distance of 2 miles, but it is very probable that there are a good many barren spots along this length, and at the north end of the old Isenhour workings there seems to have been a number of small, richer deposits pretty badly scattered. The whole mine was quite dry, especially at depth. Mr. Hambley and others said that the Isenhour vein was 9 feet thick and of good grade, and it is over 6,000 feet from the other workings."

The Southern Copper and Gold Mining Company.—The mines of this company consist of two shafts and an old prospect and a few pits along outcropping of two and possibly three veins or mineralized areas in the schists. They are located upon a hill a few hundred yards southwest of the Randolph shaft.

One shaft and the old prospect hole are probably on the same vein, which appears to have the same trend as the schistosity, while the other is on a vein lying almost 200 feet to the southeast.

The rock in which the two veins occur is very different in texture, thus showing well the variations that are met with in the country rock. The rock at the shaft and old prospect is light in color and very fine and dense in texture and is either a fine tuff much silicified or a mashed

rhyolite, while that at the other shaft, the shaft nearest the boiler house, is a typical mashed, coarse-grained tuff. The ore in this shaft is also very different from that in the former and consists of auriferous pyrite and chalcopyrite with small amount of sphalerite and galena in a silicified and quartzose portion of the country tuff. There is considerable evidence of replacement of the schists by the ores and by quartz. This ore, while not so rich as that in the north vein of the 800-foot level of the Randolph vein, in general appearance does not differ essentially from it. It clearly belongs to the silicious type of vein.

The shaft on this vein is about 200 feet deep and drifts are now being driven at right angles to the trend of the vein with the intention of exploring two more so-called veins that lie near the main vein, one to the northwest of it and the other to the southeast.

The ore in the other shaft, the one nearest the mill, consists for the most part of sphalerite, galena and pyrite, with more or less chalcopyrite, all the sulphides being auriferous, in narrow seams in the country rock, the opened up planes of schistosity. There is apparently little or no replacement of the country rock either by ore or quartz, and the vein is apparently of the rifted schist type. The ore and the country rock of this vein resemble very closely the ore and rock of the Silver Hill Mine.

A few hundred tons of the upper and decomposed ore have been hoisted and milled. The values are said to have been high, but the gold was reported to be "rusty" and not to amalgamate well.

Aside from air tools, the mine is fairly well equipped. There is a small, well-built mill equipped with ten stamps, amalgamating plates and Wilfley tables.

The Barringer Mine.—This mine, situated near Misenheimer station and about 4 miles southeast of Gold Hill, was opened prior to 1824* and was probably the first mine in the State to be opened upon a true gold-bearing vein. It was probably the discovery of this vein that caused prospecting for other veins in the "gold country" to be begun. Prior to its discovery, all the gold was thought to be only in the placer workings.

The vein is located in the "slates" at the contact with a mass of igneous rock-diabase, probably a large diabase dike, and differs from the other veins of the district in that the gangue mineral was largely calcite. The vein is said to be very narrow. A 3-inch seam in the vein is reported to have been nearly one-half pure gold, and the values throughout the vein are reported to have been very irregular, varying in assay value from about \$2 to more than \$500 per ton. The vein is also said

*A Report on the Geology of North Carolina. Denison Olmstead, Raleigh, p. 34.

to have been much disturbed by faulting. It has been estimated that nearly \$100,000 have been taken from the one ore shoot of the mine. The workings of the mine have been very irregular and much money was spent in trying to find more ore like that of the upper levels, but with little success. The plans and elevation made from surveys of the mine, now in the office of the Whitney Company, the owners of the mine, show the character of the work and the relation of the vein to the wall rock and the diabase dike.

GREENSTONE TYPE.

Southwest of the Whitney Mine the zone of mineralization passes into the greenstone area, and in this formation occur numerous small veins which have a distribution similar to those of the Gold Hill type, many small veins in parallel and closely spaced fractures. These veins have the same general northeast trend as those at Gold Hill, but in character and kind of ore and gangue of material they differ radically from the type.

The ores consist of bornite and chalcocite in a quartz and epidote gangue. The veins are usually well defined and may be easily traced on the surface by the débris of quartz and epidote. At times they consist only of stringers of the ore in narrow fractures in the rock, the rock showing more or less epidotization. This is so radically different from the Gold Hill type of deposit that one appears to have entered an entirely different region the moment he passes from the "slate" deposits into those of the greenstone.

Little prospecting has been done on these veins and consequently little could be learned as to their character. The prominence of the outcroppings depends upon the character of the vein material. Quartz and epidote veins have very prominent outcroppings, while those with little or no gangue materials are inconspicuous and possibly consist of a slightly prominent exposure of the rock only with copper stainings. Generally they are considered as "copper veins" rather than "gold veins," although they all carry a small value in gold.

In character these veins are exactly like the "Virgilina" type of vein. The definition given by Mr. W. H. Weed† for this type of southern copper deposits is equally applicable to these. He says: "The first type of deposit is that of a true fissure-vein, the quartz vein, formed by the filling of open cavities, with only minor and accessory replacements of country rock. The Virgilina deposits are representatives of this type. The ore is glance and bornite with little or no chalcopyrite or pyrite."

†Types of Copper Deposits in the Southern United States. W. H. Weed, Trans. Am. Inst. Min. Eng., Vol. 30, p. 452.

Some of the prospects in veins of this type are as follows: two shallow shafts on the Barringer plantation a short distance southwest of the Isenhour Mine; several shallow pits on land belonging to George P. Kluttz; the Harkey diggings near Five Pines, and the "Hopkins Mines" near Foil's mill. In all of these the veins appear to be small and unpromising.

THE CLINE TYPE.

This type of deposit differs from the greenstone only in the gangue minerals and the ore, the character of vein being the same. The ores in this type consist of auriferous pyrite and chalcopyrite in a gangue of quartz, calcite and siderite, and associated with varying amounts of specular hematite. This type occurs in both the greenstone and the diorite near their contact.

Only two prospects have been opened, neither of which was accessible during the field work; little, therefore, can be said about them. The two examples are the Cline Mine and the Dan Hopkins diggings near Cross Roads.

Both prospects are said to have contained considerable gold. Little work has been done at either, but the trenching and cross-cutting, as well as the shafts, show well-defined veins varying in width from 2 to 4 feet and trending N. 35° W.

THE DUTCH CREEK TYPE.

This type is similar in all respects to the Cline type except that the veins occur in the granite.

The ore consists of auriferous pyrite with a small amount of chalcopyrite in a gangue of quartz, with a little siderite. The prospects of this type are the Dutch Creek Mines, the Gold Knob Mines and the diggings in the vicinity of Garfield. They are all, except the Dutch Creek prospects, long since abandoned, but it is said that in the early workings considerable gold was obtained. The trend of the vein or stringers appears to be invariably toward the northeast.

The Dutch Creek Mines.—These are simply prospects belonging to Mr. A. H. Graf, of Salisbury. Several years ago a considerable amount of prospecting was done in this vicinity and three or four shallow shafts were sunk upon the richer veins. A small mill was erected and it is reported that considerable gold was secured in the upper workings from the shafts and from pits. The veins are narrow and irregular, but the ores are reported to have carried high gold values.

Recently Mr. Graf has reopened one of the most promising of the old shafts. The shaft was sunk so as to intersect a small vein outcropping on the surface and having a rather flat, southeast dip, about 45°. The ore shoot at the surface, while the values were exceptionally high,

was short and narrow. As it was followed downward, the values still remained good and the shoot lengthened and widened very materially, until, at a depth of about 60 feet, it has a width of from 3 to 6 feet and was about 60 or 100 feet long. The vein is in the granite at the contact with a decomposed basic dike which appears to be a gabbro. The ores consist of free gold in pyrite with a little chalcopyrite. The values are high and it appears as if there may be a small but valuable deposit of ore at the place. The work has not been extensive enough to warrant any very definite statements as to the value of the deposit.

PRODUCTION.

At the beginning of the year 1907 the outlook for the production of copper in the State was for a considerable increase during the year over that of the previous year, but on account of the financial depression that occurred during the last six months of 1907, there was a falling off in the actual production of copper. The copper produced in 1907 was obtained from Rowan, Person, Granville and Davidson counties, given in the order of the value of their production, and amounted to, approximately, 11,011 tons of ore, and the value of the copper content was \$116,416. This is a decrease of \$19,413 in value and of 718 tons in quantity as compared with 11,729 tons valued at \$135,829, the production of 1906. From the 1907 tonnage there was produced 597,878 pounds of copper as compared with 703,775 pounds obtained from the ore produced in 1906, a decrease of 105,897 pounds. This large decrease in pounds of copper obtained as compared with the relatively small decrease in tonnage is due to the fact that there was shipped from the Blue Wing Mine a considerable tonnage of copper ore from the dumps where it had been thrown during previous mining when the price of copper was at a much lower figure. Some of this ore shipped did not run over 2 per cent. copper, but at the high price of copper during the early part of 1907, it made a profitable ore to ship from the dumps.

There is given in the following table the production of copper ore, the amount of copper obtained from this and its value for the years 1900 to 1907, inclusive.

PRODUCTION OF COPPER FROM 1900 TO 1907.

Year.	Crude Ore Mined.	Copper Produced.	Value.
	<i>Tons.</i>	<i>Pounds.</i>	
1900 -----	6,948		\$ 41,600
1901 -----	10,398	512,666	76,900
1902 -----	16,741	1,417,020	212,553
1903 -----	4,106	458,133	67,037
1904 -----	4,250	305,000	36,600
1905 -----	10,000	488,888	88,000
1906 -----	11,729	703,775	135,829
1907 -----	11,011	597,878	116,416

IRON.

North Carolina contains numerous deposits of iron ore, but they represent resources of the future rather than available sources of income at the present time. There are but few of the iron ore deposits in the State that are capable of being developed and operated profitably at the present time, this being due to the price of pig iron and the distance of the ores from furnace and from sources of supply of fuel and flux. There is one property, however, in the State that has been a nearly constant producer of iron for the past twenty years, although some years the production has been very slight. This is the Cranberry iron mine, at Cranberry, Mitchell County. This mine produces a pig iron of exceptional quality and usually it commands a higher price than ordinary pig iron. The ore mined is a magnetite.

PRODUCTION.

During 1907 the production of iron ore in North Carolina amounted to 75,638 tons valued at \$113,488 at the mine. This ore was all obtained from Mitchell County. As compared with the production of 56,057 tons, valued at \$75,638, the 1906 production, it is an increase of 19,581 tons in quantity and of \$37,850 in value. The following table gives the production of iron ore in North Carolina from 1900 to 1907, inclusive:

PRODUCTION OF IRON ORE IN NORTH
CAROLINA, 1900-1907.

Year.	Amount Long Tons.	Value.
1900-----	21,000	\$ 42,000
1901-----	2,578	4,997
1902-----	34,336	52,771
1903-----	82,851	78,540
1904-----	64,347	79,846
1905-----	56,282	70,352
1906-----	56,057	75,638
1907-----	75,638	113,488

TIN.

There continues to be considerable interest in the tin mines of the State, and during the past year there has been a certain amount of development work done in Lincoln County by the Piedmont Tin Mining Company and at some of the properties in Cleveland and Gaston counties. There was a small amount of tin concentrates produced and shipped during 1907, but as the producer does not wish to have these figures given publicity, the production is only included in the total production.

ABRASIVE MATERIALS.

There is still a demand for corundum and the users of this abrasive are in the market for new sources of supply. Since the development of the deposits in Canada, the price of corundum has been lowered so that it is now quoted at from 5 to 7½ cents per pound, as compared with 10 cents when the mineral was formerly mined rather extensively in North Carolina. The best known deposits of this mineral in the State are those at Corundum Hill and Ellijay Creek, Macon County, and Buck Creek, Clay County, and are still controlled by the International Emery and Corundum Company of New York, who have not, however, done any work on these properties since they purchased them. On account of the uncertainty of the cost of production of corundum and its abrasive value, purchasers of properties containing this mineral are not willing to put up any large amount of money on options, and any one owning such a property would do well, in attempting to dispose of same, to make rather liberal options to any purchaser who is willing to develop the property to ascertain its value. The corundum deposits of the State are described in detail in Volume I of the Survey publications.

Garnet is another abrasive material that is mined to some extent in North Carolina. While the demand for this type of abrasive is somewhat limited, there is still a good market for a superior quality of garnet, which is used principally in the manufacture of garnet paper for the boot and shoe trade.

The other abrasive material produced in North Carolina is millstones, which are made in Rowan County from a granitic rock.

PRODUCTION.

The total value of the production of abrasive materials in North Carolina during 1907 was \$15,469, including garnet and millstones. In the following table there is given the production of abrasive materials from 1901 to 1907, inclusive:

PRODUCTION OF ABRASIVE MATERIALS, 1901-1907.

Year.	Corundum.		Garnet.		Millstones.		Total Value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Tons.		Tons.		Pairs.		
1901 -----	325	\$ 48,840	775	\$ 43,000	-----	-----	\$ 91,840
1902 -----	-----	-----	260	10,040	50	1,425	11,465
1903 -----	-----	-----	*403	12,250	63	902	13,152
1904 -----	-----	-----	*202	6,586	208	6,500	13,086
1905 -----	-----	-----	-----	-----	196	2,652	11,652
1906 -----	†1,150	9,000	-----	-----	205	4,100	4,100
1907 -----	-----	-----	-----	-----	-----	-----	‡15,469

*Including production of corundum.

†Including production of garnet.

‡Including corundum, garnet and millstones.

MICA.

Mica is one of the minerals for which North Carolina is especially noted, and this mica has been known as "standard mica" from the time it was first put on the market. It is a superior quality of mica for practically all purposes except in electrical work. For use in such apparatus the phlogopite variety gives fully as good satisfaction and in some instances better.

North Carolina continues to be the largest producer of mica in the United States and, during the past year, it amounted to about five-eighths of the total production of this country. It is, however, but about one-fourth of the total value of mica that is imported into this country each year.

PRODUCTION.

The total value of the production of mica in North Carolina in 1907 amounted to \$225,206, consisting of 645,221 pounds of sheet mica valued at \$209,956 and 1,371 short tons of scrap mica valued at \$15,250. This is only an increase of \$4,200 in value, but a decrease of 155,219 pounds valued at \$205,756, the production of 1906. The scrap mica produced in 1907 is an increase of 242 short tons in quantity and of \$3,310 in value as compared with the production of 1,129 tons valued at \$11,940 in 1906. This is an average of \$11.12 per ton for the scrap mica.

One noticeable change in the mica industry in the State is that there is more of the mica manufactured in North Carolina than formerly and more of the scrap mica is ground in the State. This means that a proportionally larger price is received for the mica in North Carolina where formerly the rough blocks or "thum trimmed" mica was shipped out and manufactured into the forms desired for use outside the State.

The 1907 production of mica was obtained from the following counties, named in the order of the value of their output: Mitchell, Yancey, Macon, Jackson, Haywood, Transylvania, Ashe, Lincoln and Watauga. Stokes County, which was a producer in 1906, reported no production in 1907.

There is given in the following table the approximate value and distribution of the production of sheet mica by counties for the years 1902 to 1907, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA DURING 1902-1907, BY COUNTIES.

County.	1902.	1903.	1904.	1905.	1906.*	1907.*
Ashe -----	\$-----	\$ 1,000	\$-----	\$-----	\$ 4,000	\$ 1,500
Buncombe -----	250	300				
Caldwell -----			10,000			
Haywood -----	20,000	18,000	34,500	33,710	15,975	17,000
Jackson -----	5,700	5,500	924	7,900	20,899	31,625
Lincoln -----					210	300
McDowell -----	600	1,000				
Macon -----	4,000	3,500		1,500	47,866	34,525
Madison -----				90		
Mitchell -----	28,203	29,000	21,500	17,950	51,540	76,846
Stokes -----	1,000	7,500			731	
Transylvania -----	750	500		600	11,275	3,500
Watauga -----				350	916	30
Yancey -----	21,150	20,000	34,000	38,800	64,284	59,880
Total -----	81,653	86,300	100,724	100,900	217,696	225,206

*In 1906 and 1907 the values by counties include the value of both sheet and scrap mica.

The next table gives the value of the total production of mica, including both sheet and scrap, for the years 1900 to 1907, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA,
1900-1907.

Year.	Sheet Value.	Scrap Value.	Total Value.
1900 -----	\$ 65,200	\$ 36,262	\$101,462
1901 -----	79,849	14,200	94,049
1902 -----	81,653	2,219	83,872
1903 -----	86,300	2,400	88,700
1904 -----	100,724	3,410	104,134
1905 -----	100,900	3,375	104,275
1906 -----	205,756	11,940	217,696
1907 -----	209,956	15,250	225,206

In order to show the ratio of the production of mica in North Carolina to the total production in the United States and the value of the imports, there is given in the next table figures covering these points for the years 1903 to 1907, inclusive:

PRODUCTION OF MICA IN THE UNITED STATES AND
IN NORTH CAROLINA AND THAT IMPORTED
INTO THE UNITED STATES FROM 1903-1907.

Year.	Production in N. C.	Production in U. S.	Import.
	Value.	Value.	Value.
1903 -----	\$ 88,700	\$ 143,128	\$ 317,969
1904 -----	104,134	120,316	263,714
1905 -----	104,275	178,588	403,756
1906 -----	217,696	274,990	1,042,608
1907 -----	225,206	392,111	952,259

As is seen from the above table, the amount of mica imported is very largely in excess of that produced in this country, showing that the demands for this mineral are increasing and that any good mica deposit is worthy of development.

Value of mica.—Mica varies quite widely in value according (first) to the quality and (second) to the size of the sheet that can be cut. The average price per pound of the North Carolina mica was 32.5 cents, the prices ranging from a few cents to about \$3 per pound for the larger sheets. The value of scrap mica has steadily increased, and in 1907 the average value per ton received for this form of mica was \$11.12. This mica represents the small particles of badly broken or shattered blocks, ruled mica, etc., obtained in mining and the waste obtained in cutting the sheet mica. This latter form of scrap mica is usually of greater value than that obtained in mining on account of its being cleaner, clearer and freer from impurities.

QUARTZ (Flint).

Quartz is a mineral that is used for a great variety of purposes, such as in the manufacture of pottery, where the quartz is used to diminish shrinkage and also in the glaze. There is one point that must be taken into consideration regarding the quartz used for this purpose and that is, it must be very free from any iron-bearing mineral. In general, quartz for this purpose must not contain over one-half of one per cent. of iron oxide. It is also used very extensively in the manufacture of glass, and here again the percentage of metallic oxides must be very low, hardly more than traces, in order that the glass manufactured may be perfectly clear and colorless.

On account of its hardness, which is 7, quartz is used extensively in the manufacture of sandpaper, in scouring soaps and powders, metal cleaners, etc. The very finely ground or powdered quartz is used to some extent as a substitute for pumice by dentists in connection with their work. Another use of the finely powdered quartz is in the manufacture of a wood filler. For the manufacture of sandpaper the massive quartz, which has to be crushed, thus giving the resulting quartz grain a sharp, cutting edge, is much superior to the quartz sand which, is rounded and, even when crushed, only has a portion of its edges sharp. This quality is also objectionable in the use of sandstone for this purpose on account of the grains of quartz in the sandstone being rounded.

Another extensive use is as a flux in copper smelting, and there are a number of smelters that are purchasing large quantities of this mineral for this purpose.

Massive quartz in the form of blocks is used in the chemical industry as a filler for acid towers. It is for these last two purposes that practically all of the quartz mined in North Carolina is used.

If pottery or porcelain industries can be established in North Carolina to utilize the kaolin and other grades of clay in the State, there would be a demand for a considerable quantity of the quartz that occurs in Piedmont and western North Carolina.

PRODUCTION.

The production of quartz in North Carolina in 1907 amounted to 4,226 short tons of crude quartz valued at \$1,664. This is a decrease of 16,737 tons in quantity and of \$10,914 in value, as compared with 20,963 short tons valued at \$12,578, the production of 1906. In the following table there is given the production of North Carolina for the years 1901 to 1907, inclusive:

PRODUCTION OF QUARTZ IN NORTH
CAROLINA, 1901-1907.

Year.	Quantity.	Value.
	<i>Tons.</i>	
1901 -----	3,000	\$ 7,500
1902 -----	4,500	11,250
1903 -----	29,462	36,827
1904 -----	32,972	36,269
1905 -----	32,648	13,659
1906 -----	20,963	12,578
1907 -----	4,226	1,664

BARYTES.

The barytes industry in North Carolina is not a large one, although the quality of the barytes produced is equal to any. It is hard and compact and usually very free from iron stains. Its hardness and compactness make it a little more difficult to grind than the softer varieties.

PRODUCTION.

The production of crude barytes in North Carolina in 1907 amounted to 5,785 tons valued at \$18,855, which is an increase of 2,445 tons in quantity and of \$8,835 in value, as compared with 3,340 tons valued at \$10,020, the production of 1906. This production was obtained from Madison and Gaston counties, there being one producer in each county.

In the following table there is given the production of barytes in North Carolina for the years 1901 to 1907, inclusive:

PRODUCTION OF CRUDE BARYTES IN
NORTH CAROLINA, 1901-1907.

Year.	Quantity, Short Tons.	Value.
1901 -----	6,890	\$20,865
1902 -----	14,679	44,130
1903 -----	6,835	21,347
1904 -----	13,413	33,930
1905 -----	5,545	21,670
1906 -----	3,340	10,020
1907 -----	5,785	18,855

MONAZITE.

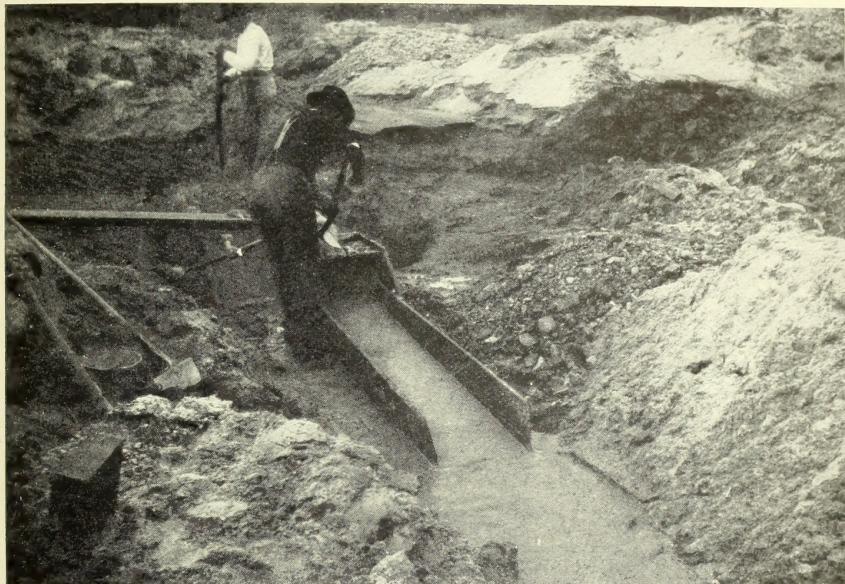
One of the most important events in connection with the monazite industry during the past year has been the extension of the monazite area into Alexander County, where commercial deposits of this mineral have been located and purchased by the National Light and Thorium Company. It is interesting to note the extension of the monazite area since this mineral was first mined in the Carolinas in 1893, when it first became a real industry in the State. At that time the known monazite field was an area of about 2,000 square miles in Burke, Catawba, Cleveland, Gaston, Lincoln, McDowell, Polk and Rutherford counties in North Carolina and extending into Spartanburg and Greenville counties, South Carolina. Now the area is known to cover approximately 3,500 square miles, including, besides the above-named counties, portions or all of Alexander, Caldwell and Iredell counties in North Carolina, and Anderson, Cherokee, Laurens, Oconee and Pickens counties in South Carolina. The discovery in 1907 of the Alexander County monazite deposits is the direct result of prospecting by the National Light and Thorium Company of Youngstown, Ohio.

The commercial deposits of monazite in North Carolina are the gravel beds in streams and bottom lands and in certain places the surface soils which adjoin gravel deposits. Mill tests and laboratory tests have been made upon the monazite-bearing rock, but thus far no deposit has been discovered that could be mined profitably. Occasionally certain portions of the saprolitic rock in close proximity to the gravel beds, especially that immediately underlying them, has been scraped up and washed, giving a small margin of profit. The monazite in these gravel beds has resulted from the alteration and erosion of the monazite-bearing rocks and this mineral has been concentrated by nature in these gravel deposits. The percentage of monazite in the sands extending from sur-

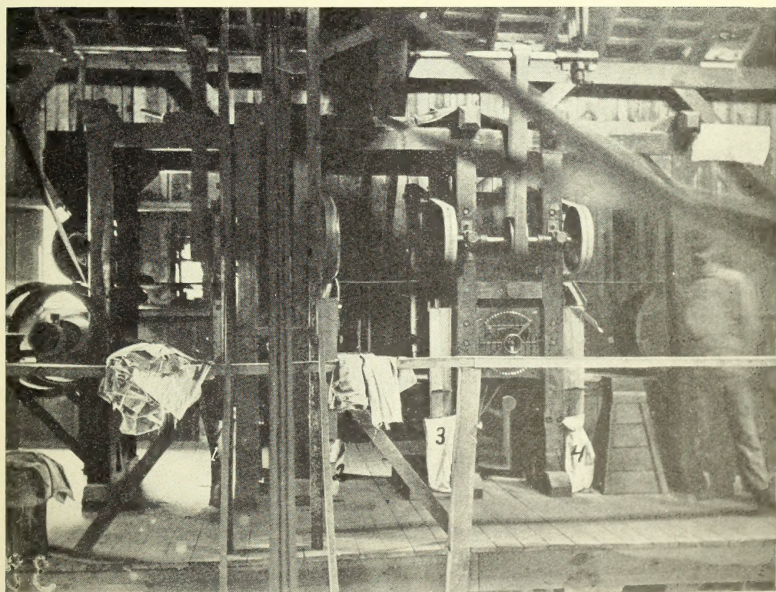
face to bed rock is not over one per cent. per cubic yard. This, however, is sufficient to make profitable mining. In many localities it has been the custom to sluice not only the gravels but all the overburden, inasmuch as even the top soil carries a small amount of monazite. There are no large hydraulic plants in operation, but nearly all the monazite is obtained in sluice boxes fed by hand. (Pl. VI, A.) These boxes are fitted at their upper end with a sieve or shaking hopper with a screen of about No. 12 mesh. The boxes vary in length from 8 to 20 feet and in some instances are fitted with riffles holding mercury for catching the gold.

The concentrates from these sluice-boxes have to be dried before they can be treated on the magnetic separators. There are two different methods used in the monazite district for this purpose. In one the sand is spread over an oil or rubber cloth in a thin layer and exposed to the heat of the sun. It dries very quickly, due, perhaps, to the heat absorbed by the dark iron sand. It requires, however, a considerable surface to accommodate any large amount of sand. The other method of drying is by heating over a furnace. A small ditch is dug from 4 to 8 feet long, $1\frac{1}{2}$ feet wide and about 1 foot deep, at one end of which is built a rock or brick chimney. The ditch is usually built up of stones with an opening at the opposite end of the chimney for firing. Over the ditch there is a sheet-iron cover or drying plate. The monazite is spread on this and exposed to the action of the hot fire underneath. These dried sands are often further concentrated by means of the ordinary horseshoe magnet, which picks out all the magnetite. The miners or producers of this sand are paid for it on the basis of a 100 per cent. product. The sand brought into the magnetic concentration plants is worth from 4 to 8 cents per pound. Its value is increased, however, after being run over these machines, from 12 to 20 cents per pound. This material represents what is known as crude monazite sand and contains, besides the monazite, varying amounts of magnetite, ilmenite, garnet, zircon, rutile, corundum, cyanite, quartz (occasionally), hornblende and, rarely, chromite. In order to separate the monazite from these associated minerals, it is necessary to run this crude sand through some electro-magnetic separator, such as the Wetherill, or some modification of this type of machine which is in most general use. (Pl. VI, B.)

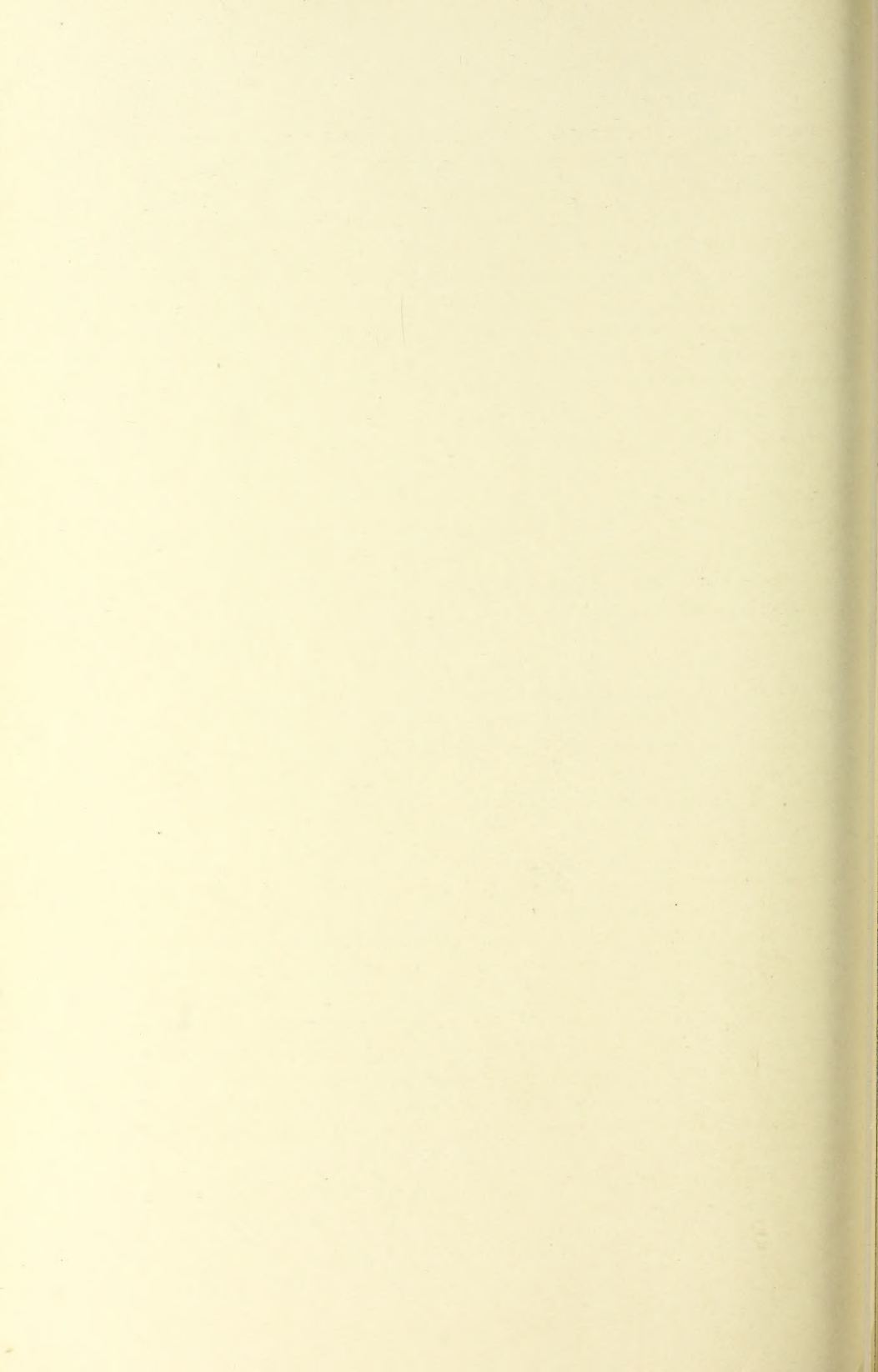
There are many substances that are attracted by electro-magnets that are not apparently influenced at all by the strongest steel magnet, and for this reason many substances which were formerly considered non-magnetic have been proved to be magnetic when subjected to the intense magnetic field obtained in an electro-magnetic separator. All substances



A, WASHING MONAZITE GRAVEL, CLEVELAND COUNTY.



B, WETHERILL MAGNETIC SEPARATOR AT GERMAN-AMERICAN MONAZITE COMPANY'S
PLANT, OAK SPRINGS, N. C.



are, of course, either attracted or repelled by magnets, the former being called paramagnetic and the latter diamagnetic. The latter class is the most numerous, but since the introduction of the electro-magnets, the former class, which up to this time had been considered extremely small, has been largely increased. The paramagnetic substances are the metals iron, nickel, cobalt, manganese, chromium, cerium, palladium, platinum, osmium and many of their salts and compounds. The degree of attraction of these varies very widely, and thus it is possible by using the electro-magnetic separators, which can be regulated so as to give a very strong field and at the same time a field which is capable of fine adjustment, to separate not only the paramagnetic from the diamagnetic substances, but also to separate the paramagnetic from each other. As will be observed from the list of associated minerals of monazite given above, many of them are salts of the metals that are paramagnetic and it is possible by the use of the separators mentioned above to obtain a monazite sand of from 90 to 99 per cent. monazite, depending on the care that is exercised in separating it. It is the cerium in the monazite that makes it a magnetic substance.

The other products, as the iron minerals, magnetite, ilmenite and garnet, can also be obtained in a very pure state. From a long series of experiments* that have been carried on, it has been determined that when treated in the Wetherill electro-magnetic separator or a similar type of machine that magnetite can be removed with an amperage of .2; ilmenite with 1.1; chromite with 1.6; garnet with 1.75; hypersthene and olivine with 2.2; monazite with 3.5, and hornblende with 5.

USES OF MONAZITE AND ITS ASSOCIATED MINERALS.

The commercial value of monazite depends upon the incandescent properties of the rare earth oxides which it contains, such as cerium, lanthanum, didymium and thorium oxides, which are used in the manufacture of the Welsbach and other incandescent gaslight mantles. It is the thoria that is used in largest amount and which gives the actual value to the monazite. In the reduction of the monazite sand, there are a long series of salts that are obtained in considerable quantity, which have made it possible to carry on extensive series of experiments with these rare earth oxides. It requires from 4 to 6 months to recover from the monazite sand its percentage of thorium and render it sufficiently pure to be used in the mantles.

The Welsbach light consists of a cylindrical hood or mantle composed of a fibrous network of the rare earths, the top of which is drawn to-

*Min. Res. U. S., Geological Survey, 1905.

gether and held by a loop of asbestos or platinum wire. When in use, this mantle is suspended over the flame of a burner constructed on the principle of the Bunsen burner, in which the heating, instead of the illuminating power of the hydrocarbon of the gas, is used by burning it with an excess of air. In this manner the mantle becomes incandescent and glows with a brilliant and uniform light.

A short description of the method of manufacture of these mantles may be of interest. The first part of the process is the selection of the thread or fiber from which the mantle fabric is knitted. The fiber mostly used is cotton, either the Upland, River Bottom, Peeler, Allen Seed, Sea Island or Egyptian variety, the market price varying from about 10 cents for the Upland to 30 cents per pound for the Egyptian. The cheaper cottons are used in the lower grade mantles, the highest grade mantles requiring the best quality of cotton. The thread is purified so as to remove every possible trace of mineral matter. If the thread used shows a mineral impurity above .015 per cent., it will introduce factors that will affect the physical and lighting life of the mantle. Cylindrical networks of varying diameters are knitted out of the thread and then washed in ammonia and distilled water and wrung out in mechanical clothes wringers. After it is dry, it is cut into pieces sufficiently long to make two good mantles.

These knitted fabrics are then placed in a suitable vessel and covered with the "lighting fluid." They remain in this until thoroughly saturated. The excess of fluid is drawn off and the fabric put through an equalizing machine piece by piece. The "lighting fluid" is composed of a solution of approximately 99 per cent. thorium nitrate and 1 per cent. cerium nitrate in distilled water, in the ratio of 3 parts of water to 1 part of mixed nitrates. The fabric is dried and then cut to the proper length required for a hood. They are then shaped over a wooden form and the upper end drawn together by means of an asbestos cord, but occasionally of platinum wire. After the mantle has been modeled, the cotton fiber is eliminated by heating them over a hot Bunsen burner flame, leaving the mantle composed of the ash of thorium and cerium. The peculiarity of these oxides is that they have sufficient cohesion to hold together during the balance of the process of manufacture, after every bit of the supporting cotton thread has been burned away. During a series of tempering and testing heats, the mantle is carefully shaped to its permanent form. In order to protect the ash of the mantle during its inspection, packing, transportation and installation, it is dipped in collodion.

Just before using the mantle the collodion covering has to be burned off. It is estimated that the American market consumes at least 40,000,000 of these mantles per year.

Another element obtained from the monazite is didymium, whose oxide is dark brown. Use is made of this for branding the mantles with an indelible brand. A nitrate solution is made and an ordinary rubber stamp used for branding.

Of the associated minerals, zircon has a considerable commercial value of 20 to 25 cents per pound for its zirconia content, which is used in the manufacture of the glower of the Nernst lamp. The fundamental principle of this Nernst lamp is that certain of the rare earths or refractory oxides will conduct an electric current and glow after they have been heated to redness. This discovery, which was made by Dr. Nernst in 1897, has resulted in the development and perfecting of the glower which is now embodied in the Nernst lamp. This glower is composed of a mixture of the rare earth oxides and is made in the form of a small rod or pencil of chalk-like material, having wire terminals at either end. When cold, the glower is an insulator, but by means of the wire the glower becomes heated to redness when a current is passed through these wires, and its resistance gradually decreases until it has reached a red heat, when with 220 volts across the terminals, it starts to conduct the current and give light.

In bringing a glower up to its starting point corresponding to a temperature of 1,200° F., use is made of a small electrical heater composed of two or more small tubes of porcelain about 1½ inches long and ¼ inch in diameter, which are overwound with fine platinum wire, this being in turn held in place and protected from the intense heat later generated by the glower by an outer coating of porcelain paste. After the glower becomes heated, there is, of course, no further use for the heater, and it is cut out by a small electro-magnet cut-out, which consists of a magnetic coil connected in series with the glower, an armature and the necessary contacts in the heater circuit. Thus, when the glower has become heated sufficiently, the current begins to pass through it, and when this becomes sufficiently strong, the armature is attracted and the contacts are separated, thus disconnecting the heater from the line. The surface of the glower, before being used, presents a smooth, white, porcelain or chalky appearance, but, after having been in use about 500 hours, it is rough or crystalline in appearance.

The yttria contents used in the manufacture of the Nernst glower are obtained principally from the mineral gadolinite, which has not thus far been found in the State.

The magnetite and ilmenite may find a use in the manufacture of magnetite electrodes that are manufactured by the General Electric Company.

The garnet grains are sharp and can be used for abrasive purposes in the manufacture of garnet paper, which is used extensively in the boot and shoe trade.

PRODUCTION.

There was a large falling off in the production of monazite in North Carolina during 1907 compared with 1906 on account of the continued low price of thorium nitrate, which caused a reduction in the price of monazite sand from 20 to 12 cents per pound for the refined sand. This decrease in price made it impossible for a number of the monazite properties to be operated at a sufficient profit to warrant their being worked. The production amounted to 456,863 pounds valued at \$54,824, as compared with 697,275 pounds valued at \$125,510, the production of 1906, this being a decrease of over 100 per cent. in value and approximately 50 per cent. in quantity. This production was obtained from Cleveland, Rutherford, Burke, Iredell, Alexander and Catawba counties, given in the order of the importance of their production. This production of North Carolina is five-sixths of the total production of this mineral in the United States. One company, the British-American Monazite Company, which was a producer in 1906, closed out and sold their property and machinery. This is the company that attempted to mine the monazite-bearing rock, but found it to contain too low a percentage of monazite, although they had no difficulty whatever in obtaining a very clean product.

In the table below there is given the production and value of monazite mined in North Carolina from 1893 to 1907, inclusive:

PRODUCTION OF MONAZITE IN NORTH
CAROLINA, 1893-1907.

Year.	Monazite.	
	Pounds.	Value.
1893 -----	130,000	\$ 7,600
1894 -----	546,855	36,193
1895 -----	1,573,000	137,150
1896 -----	30,000	1,500
1897 -----	44,000	1,980
1898 -----	250,776	13,542
1899 -----	350,000	20,000
1900 -----	908,000	48,805
1901 -----	748,736	59,262
1902 -----	802,000	64,160
1903 -----	773,000	58,694
1904 -----	685,999	79,438
1905 -----	894,368	107,324
1906 -----	697,275	125,510
1907 -----	456,863	54,824

ZIRCON.**PRODUCTION.**

There was but a very small production of zircon in North Carolina in 1907, amounting to only 204 pounds valued at \$46. This was obtained from the Jones Mine, in Henderson County, which is the mine that has produced all the zircon sold during the past ten years. In the following table there is given the production and value of zircon mined in North Carolina from 1902 to 1907, inclusive:

PRODUCTION OF ZIRCON IN NORTH
CAROLINA FROM 1902 TO 1907,
INCLUSIVE.

Year.	Pounds.	Value.
1902 -----	2,000	\$ 380
1903 -----	3,000	570
1904 -----	1,000	200
1905 -----	8,000	1,600
1906 -----	1,100	248
1907 -----	204	46

TALC AND SOAPSTONE.

There continues to be a large demand for a quality of talc such as is found in Swain County and is now only produced by the North Carolina Talc and Mining Company at Hewitt. This is an exceptional quality of talc and the deposits cannot supply the demand for this talc to be used in the manufacture of tailors' pencils, gas tips, etc. The State has been pretty well prospected for similar deposits, but thus far none have been located, although large deposits of other qualities of talc suitable for grinding into talcum powder, for the manufacture of soapstone tubs, etc., are known.

Where formerly practically all of the talc mined in North Carolina was shipped out of the State, there is now a certain quantity of the ground talc utilized within the State by the Talcum Puff Company of Asheville, who are manufacturers of talcum powders. They produce their own talc in Swain County, and, on account of the purity of the talc, they are able to put on the market an exceptional quality of talcum powder.

PRODUCTION.

During 1907 there was produced 4,085 short tons of talc and soapstone valued at \$74,347. This is a decrease of 99 tons in quantity but an increase of \$7,368 in value as compared with 4,184 tons valued at \$66,979, the production of 1906. This increase in value with a decrease in tonnage is due to the better quality and higher priced articles

manufactured from talc in 1907. This production was obtained from Swain, Moore, Jackson and Alleghany counties, given in the order of the value of their productions.

As there is very little talc sold in the crude state, the values are for the production as it was marketed and usually represents the manufactured product. In the table below there is given the condition in which the 1907 production was marketed together with the productions for 1905 and 1906:

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA DURING
1906 AND 1907.

Condition in Which Marketed.	1905.		1906.		1907.	
	Quantity, Short Tons.	Value.	Quantity, Short Tons.	Value.	Quantity, Short Tons.	Value.
Ground talc for powders, etc.	3,529	\$ 39,007	2,094	\$ 19,925	2,245	\$ 24,514
Talc cut into pencils, gas tips, etc.	205	32,568	1,020	35,688	160	43,034
Talc sold crude	301	3,115	895	11,116	1,580	5,999
Soapstone cut into slabs for chimneys, etc.	-----	250	-----	250	100	800
Total	4,035	74,940	4,009	66,979	4,085	74,347

In the following table the quantity and value of talc and soapstone produced in North Carolina from 1898 to 1907 is given:

PRODUCTION OF TALC AND SOAPSTONE IN NORTH CAROLINA,
1898 TO 1907, INCLUSIVE.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	<i>Short Tons.</i>			<i>Short Tons.</i>	
1898	1,695	\$ 27,320	1903	5,331	\$ 76,984
1899	1,817	31,880	1904	3,801	65,483
1900	4,522	75,308	1905	4,035	74,940
1901	5,819	77,974	1906	4,184	66,979
1902	5,239	88,962	1907	4,085	74,347

PRECIOUS STONES.

There was but very little systematic mining for gems in North Carolina during 1907, and a number of the well-known gem localities were not operated at all. The gem material produced during the year included ruby, emerald, beryl, hiddenite, quartz, amethyst, rutile, cyanite, feldspar and garnet. There was one piece of milky opal reported as having been found in Iredell County. Brief notices of some of the gem material found and properties operated are given below, and have been taken from the report of Mr. Douglas B. Sterrett, of the U. S. Geological Survey.*

*The Production of Precious Stones in 1907. Advance Chapter, Mineral Resources of U. S. Geological Survey for 1907.

*Ruby.**—Interest in the ruby deposits along Caler Fork of Cowee Valley, Macon County, N. C., has been revived through operations of the United States Ruby Mining Company. This company has undertaken to develop the ruby in the matrix lead previously located at "In Situ Hill" in the valley, and expects to wash the ruby-bearing gravels left unworked during former mining operations. For a distance of over 2 miles rubies have been found in the creek gravels, much of which has been worked. The gem-bearing gravels lie both above and below the company's headquarters at the mouth of Dalton Branch. Good rubies have been found in the creek gravels about a mile above the mouth of Dalton Branch as far as "In Situ Hill." This hill is merely the end of a ridge or spur which extends from the mountains on the south side of the valley down close to the creek.

In the report of Mr. C. Barrington Brown, in 1896, to the American Prospecting and Mining Company on the ruby mine of Cowee Valley, the rubies are described as generally of good color, many resembling the true pigeon-blood ruby of Burma. Some of them have bluish borders, which give them a magenta tint. Pratt and Lewis† state that some large gems—3 or 4 carats in weight—of good color and transparency and free from inclusions, have been found. Though found in less quantity, the color and quality of these stones equal the Burma rubies. Some of the Cowee Valley rubies contain inclusions of rutile, ilmenite, garnet, etc., or are silky or badly flawed. Much pink and red corundum, some of it approaching the ruby in color and quality, is associated with the ruby. The concentrates obtained in washing for ruby contain red, pink, bluish, gray, and yellowish corundum, ilmenite, rutile, cyanite, red and pink or rhodolite garnet, small zircon crystals, quartz, feldspar, etc. In the New York office of the United States Ruby Mining Company an admirable display of ruby and ruby corundum, as well as specimens of ruby matrix material, has been arranged by Mr. Alfred H. Smith.

During 1907, Mr. N. E. Isbell, of the United States Ruby Mining Company, constructed a new ditch to carry the creek from above "In Situ Hill" along the opposite hillside, where it could be tapped for pressure for hydraulic purposes. This ditch was extended to a point opposite the mouth of Dalton Branch, where a fall of nearly 100 feet could be obtained to hydraulic the bottom lands below. Another reason for the construction of the ditch was the hope that by turning the creek from its bed close to "In Situ Hill" the flow of water in the shaft on the ruby matrix would be diminished and the surrounding

**Ibid.*, pp. 24 and 25.

†Pratt, J. H., and Lewis, J. V., *Corundum and the Peridotites of Western North Carolina*: N. C. Geol. Survey, Vol. 1, 1905, pp. 180-186.

mud become harder. A 20-horse power engine with a rotary centrifugal pump and bucket elevator were installed to assist in sinking the shaft and driving a crosscut from the bottom through the soft ground.

The matrix in which the ruby corundum occurs, and in which genuine rubies are said to have been found, consists of hornblende gneiss and pegmatite in hornblende gneiss. The pegmatite occurs in small streaks and lens-shaped pockets from an inch or two to a foot thick, roughly conformable with the bedding of the enclosing hornblende gneiss. Both the pegmatite and the hornblende gneiss are very badly decomposed at the surface. The feldspar of the pegmatite has largely decomposed into kaolin, while the hornblende gneiss has altered to the yellowish brown earth characteristic of the saprolite of that rock, with hydromica and black spots where small garnets have rotted away throughout. That this weathering extends to a depth of over 30 feet is shown by the material removed from a shaft of that depth. The strike of the country rock at "In Situ Hill" is north of east, with a high dip to the southeast. A dike of hard, unaltered hornblende eclogite outcrops in the bottom of the valley, a few feet north of the ruby matrix, and can be traced to the east and west some distance. The hornblende gneiss, saprolite, contains parallel streaks of mica-gneiss saprolite included in it.

In some of the pockets of decomposed pegmatite translucent pink to lilac colored corundum is very abundant, both in fairly large well-formed crystals and in small fragments. Red and ruby-colored corundum is less plentiful, and but few crystals of gem quality have been found in the pegmatite bodies so far. Portions of the hornblende saprolite enclosing the pegmatite carry small translucent corundum crystals and fragments, some of rich red color in small pockets of soft white material. These were probably small masses of pegmatite which have decomposed, though they might possibly represent the decomposition products of former corundum crystals. From the few specimens of matrix seen by the writer, it appeared that the corundum associated with larger bodies of pegmatite is inclined to be of a lighter color—pink or lilac—than the richer red stones in the hornblende rock alone, or where pegmatite is less prominent.

Emerald, beryl, and hiddenite.*—Emerald was obtained from three places in North Carolina during 1907. The greater part came from the emerald-hiddenite mine and the Ellis emerald mine, already described under beryl. Of the remainder, part was found at a prospect belonging to Mr. W. H. Warren, 1 mile north of Hiddenite, and part consisted of emerald matrix from Mitchell County probably mined some years ago and recently cut.

*The Production of Precious Stones in 1907. Advance Chapter, Mineral Resources of U. S. Geological Survey, pp. 10, 11 and 19.

Regular mining for aquamarine and the beryl gems was carried on in North Carolina during 1907 at Hiddenite. Scattered lots were brought in by mica miners and prospectors in other parts of the mountain country, chiefly in Mitchell and Yancey counties, though some were obtained in Iredell County and at Barretts Mountain, Alexander County.

The hiddenite and emerald mine, one-half mile west of Hiddenite, Alexander County, was reopened and worked during part of the year by Mr. Cary Wright for the American Gem Mining Syndicate. At the same time Mr. Wright opened a new prospect called the Ellis emerald mine, one-fourth mile east of Hiddenite. The work was stopped in September, 1907, pending the installation of a power plant for larger operations. Aquamarine and beautiful specimen beryl, emerald, and hiddenite were obtained in promising quantities. Mr. Wright mentions one beautiful specimen, 2 inches long by $1\frac{1}{2}$ inches in diameter, weighing over 750 carats, obtained from the emerald-hiddenite mine. It was translucent with prism faces highly polished. Many aquamarine crystals of from 10 to 20 carats were found in the same mine. Several fine crystals of aquamarine were found at the Ellis mine, two of which were imbedded in transparent quartz crystals, making splendid cabinet specimens. Emeralds of fine color were obtained from both mines. At the Ellis Mine one dark-green emerald weighing 276 carats was found. About 200 carats of hiddenite were obtained from the emerald-hiddenite mine. One crystal, weighing about 10 carats, was one-half colorless and the other half a deep emerald green. Jet black tourmaline crystals associated with feldspar; clear, colorless, smoky, and rutilated quartz crystals; rutile crystals, etc., were also found associated with the beryls.

At the emerald-hiddenite mine there are a large number of veins generally striking north of east with high dips to the north. For a distance of over 50 yards both to the north and to the south of the main workings a number of pits and several shafts have been made on different veins. In all of the veins opened quartz crystals were found, some very clear and beautiful, with well-developed crystal form. Some of these openings yielded beryl or hiddenite, occasionally of gem quality.

The old workings at the emerald-hiddenite mine were made chiefly between 1880 and 1885, and consisted of a large open cut, with two shafts near the western end, besides numerous smaller test pits in the vicinity of the open cut. The open cut is situated near the top of a low ridge and is probably 150 feet long, 20 to 40 feet wide, and 15 to 20 feet deep. A haulway had been cut to the same level at the east

end to the dump. The new work in 1907 consisted of an open pit, some 12 feet wide and 18 feet long, near the eastern end of the old cut and at the north side of the haulway. Two well-defined veins were found in this cut, and also two less promising ones. These veins were nearly parallel, and the strike measured on the best one was N. 70° E., dip about 85° N. Several good, though small, pockets were found in this cut.

The country rock in the region around the emerald-hiddenite mine and the Ellis emerald mine is chiefly biotite gneiss, garnetiferous in places, which has been much compressed and folded, probably while in a plastic condition. Veinlets of quartz in the original rock have been folded and crumpled during this compression into forms resembling folded ribbon. The country rock in the neighborhood of the veins has been highly silicified by the addition of much quartz. This quartz along with other minerals, as muscovite, rutile, pyrite, etc., has replaced the biotite and feldspars and other minerals of the country rock. This replacement was later than the compression of the rock and about contemporaneous with the deposition of the vein matter. These phases are beautifully illustrated in hand specimens which show typical biotite gneiss with folded quartz veins, several feet from a vein, and in similar rock, highly silicified, with a portion of the vein-filling adhering. In the latter specimen the vein filling a fissure is glassy quartz with calcite, rutile, and pyrite inclusions. The wall next to the vein consists largely of granular quartz and an emerald-green (chrome) muscovite, with a little rutile and pyrite. At about 1 inch from the vein the replacement of the country rock is not so complete, and biotite becomes gradually prominent in the rock. At 2 inches from the vein the rock is nearly black biotite gneiss, rich in quartz. A folded quartz veinlet cuts the gneiss to the vein wall. It is more prominent in the black gneiss than in the highly replaced gneiss, though it can readily be traced through the latter, since the quartz of which it is composed was not so easily replaced as certain constituents of the gneiss. Some of the rock cut by the veins contains much chlorite and has a yellowish-green color.

The material filling the gem-bearing veins consists of quartz, calcite, dolomite, muscovite, rutile, black tourmaline, aquamarine and emerald beryl, hiddenite, pyrite, chalcopyrite, and monazite. All of the veins in the neighborhood do not contain all of these minerals, but each of the numerous veins exposed in the workings contain some or all of them. In the cavities all of these minerals occur in crystals; in solid-vein matter certain ones only have crystal form. The calcite was introduced after the other minerals had been deposited, in many

places filling up previously existing cavities. Crystals of the other minerals are embedded in solid calcite veins, and calcite has been deposited between broken fragments of beryl and other crystals. Rutile suitable for cutting is plentiful in brilliant crystals, some long and slender, others short and thick. The crystals are commonly twinned, several crystals often joined or crossing each other at angles of 60° , forming beautiful cabinet specimens of rosettes or reticulated masses of needles. The gem minerals—emerald, aquamarine, and hiddenite—occur in distinct crystals in the veins, and when lining the walls of cavities and of good color they make a beautiful contrast with the associated gangue minerals.

The vein at the Ellis emerald mine is pegmatite, with cavities and pockets included in it. The pegmatite strikes N. 50° E., with a high northerly to vertical dip. There are stringers or arms of pegmatite along the walls, and at one place the pegmatite is composed along one side largely of small mica blocks. The country rock is biotite gneiss, small dikes of quartz diorite being included. The latter weathers out in rounded boulders or “nigger heads,” which are scattered over the surface near the mine. The quartz in portions of the pegmatite is a fairly dark rose color. So far, however, none suitable for gem purposes has been found.

Amethyst.*—In Macon County, N. C., amethyst has been found at various places in the region of Tessentee Creek, near Scaly Mountain, and to the south of Highlands. The amethyst of this region occurs in veins cutting granite gneiss and mica gneiss. The veins in which the amethyst occurs are generally irregularly filled, well-defined fissures cutting the enclosing rocks at variable angles, though generally with a high dip. Some of these veins have been traced several hundred feet. Deep-colored amethyst crystals are found in pockets in these veins, often associated with pale amethystine and colorless quartz crystals. The spaces between the crystals are commonly filled with red clay or other earthy material. The pockets range from a fraction of an inch to 15 or 18 inches in thickness, and may extend several feet along the vein. The crystals range in size from a small fraction of an inch to 3 and 4 inches across. In some of the crystals the purple color of amethyst is entirely lacking or present only in pale shades. In others the rich purple of Siberian amethyst is present. The color is generally most intense near the points of the crystals and often occurs in planes parallel to the crystal faces. This renders only portions of the crystals suitable for cutting, although much amethyst and quartz suitable for specimens only is obtained.

*Ibid., p. 7.

PRODUCTION.

The value of the production of precious stones of all kinds in North Carolina for the year 1907 was \$7,580, as compared with \$5,000, the value of the 1906 production, this being an increase of \$2,580. This production was obtained from Alexander, Macon, Iredell, Mitchell and Yancey counties, given in the order of the estimated value of their output. It has been impossible to obtain accurate figures regarding the production of precious stones, as there is a good deal of material brought in to different dealers in precious stones who keep no record whatever of the material so purchased.

In the table below there is given the production of precious stones in North Carolina for the years 1900 to 1907, inclusive:

PRODUCTION OF PRECIOUS STONES IN
NORTH CAROLINA SINCE 1900.

Year.	Value.
1900	\$ 12,020
1901	24,245
1902	5,300
1903	1,525
1904	10,600
1905	3,350
1906	5,000
1907	7,580

MINERAL WATERS.

INTRODUCTION.

Although the mineral water industry in the State is not at the present time of very great value, there is a possibility and probability of its developing into an industry of very great value to the State in two ways: First, by the bottling and shipping of the various mineral waters for medicinal and table uses; and, second, by using them in connection with hotels where the medicinal value of the water is desired by the guests.

There are scattered throughout North Carolina hundreds of mineral springs of greater or less value from a medicinal standpoint. Some of the springs contain little or no solid matter or gases, but, on account of their great purity, are of value as table water.

It is absolutely necessary, in order to create a market for mineral water, that it not only be a pure water, especially adapted for table use or containing some ingredient or ingredients that make it of special medicinal value, but it is also very necessary that the water be very widely advertised. If it is to be put on the market in pint, quart or gallon receptacles, too much attention cannot be given by the producer

to the neatness and general appearance of the bottle and label. There are but few of the springs whose waters, up to the present time, have been put on the market to any large extent.

There exists in many counties throughout the State springs and wells having a local and, in some cases, a widespread reputation for their medicinal properties, and there are still many others as yet in nowise developed and but little known that will become commercial springs. Although the present work on the mineral waters is but preliminary, it should aid in drawing attention to and extending the reputation of the springs of real value and stimulating the investigation and development of new mineral waters of genuine merit.

It is almost impossible to give a definition for mineral water that will cover every case, for the reason that any natural water that is utilized as an article of commerce, except public water supplies, would be brought under this head if it contained any mineral matter which gave it especial medicinal value or if it was an absolutely pure water which made it of special value for table use. Thus, the water may come from a well, a spring or even a lake and may contain one part or one thousand parts of solid in solution in each 1,000,000 parts of water.

The mineral waters described beyond were, in most cases, collected by some member of the Geological Survey and sealed and shipped by express or freight to the laboratory at Chapel Hill. At the same time the agent of the Survey made such observations as were possible regarding the rate of flow, temperature, escape of gases, odor, character of surroundings, etc. The analyses have for the most part been made at the laboratory of the University of North Carolina, and unless otherwise stated have been made by Dr. F. P. Venable. The bulk of the analyses were made from 1895 to 1900, but will represent pretty accurately the composition of the spring at the present time. Not all of the valuable mineral waters in North Carolina have been analyzed or described in this report, and in selecting what springs should be analyzed and described, letters were addressed to prominent persons, usually physicians, in all parts of the State, asking for information as to any spring or well in their neighborhood which had any general or local reputation or recognized therapeutic properties. Whenever such a spring was heard of, it was visited and a sample secured for analysis. It is undoubtedly true that in selecting this limited number of springs for analysis, some have been admitted which ought to have been excluded and others have been omitted which should have been included.

COMPOSITION OF MINERAL WATERS.

Mineral waters contain quite a variety of solid compounds in solution in the water and also certain gaseous compounds. The solid matter and gases vary in the different springs not only in variety but also vary largely in quantity. Such a thing as pure spring or well water entirely free from all dissolved mineral matter is practically unknown upon the earth's surface. In the first place, rain water as it falls through the earth's atmosphere would absorb a certain amount of oxygen, nitrogen and carbon dioxide. These gases, especially the carbon dioxide, would add very materially to the solvent power of the water as it comes in contact with the earth's crust and percolates through it. Some waters may only come in contact with undecomposed and difficultly soluble rocks and would have, therefore, very little action on their mineral constituents. Other waters, however, coming in contact with some porous and easily soluble rocks, might take into solution considerable quantities of mineral matter. From the soils above the rocks the waters would take considerable solid matter in solution, this varying with the character of the soil through which the water percolated. Waters that have penetrated to great depths and have become subjected to greater pressure and are at a higher temperature have their solvent power increased and are apt to contain much more mineral matter than the surface waters. The principal constituents of the mineral waters are not the most abundant ingredients of the earth's surface, but are principally the elements most needed by plants for their growth. The different elements that have been found in the various mineral springs are: Hydrogen (H), Lithium (Li), Sodium (Na), Potassium (Ka), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba), Boron (B), Aluminum (Al), Carbon (C), Silicon (Si), Nitrogen (N), Phosphorus (P), Arsenic (As), Oxygen (O), Sulphur (S), Chlorine (Cl), Manganese (Mn), Bromine (Br), Iodine (I), Iron (Fe), Cobalt (Co), and Nickel (Ni). Of the above elements, all but strontium have been reported in some of the springs of North Carolina. Just how these elements are combined in the various mineral waters is not known and many opinions are held regarding the relative probability of their formation. It is, therefore, impossible to separate out and bring into a weighable form each of the compounds which may be present in the mineral water. Thus, there may be several different compounds of calcium in the water, but it is impracticable to separate them and they are, therefore, reacted upon and all of the calcium precipitated as the oxalate and the calcium determined as calcium oxide. In reporting it as calcium oxide, it does not mean that it is present as such, but is in reality combined with one or more

of the acid radicles. Again, the sulphuric acid radicle may be combined with several of the basic radicles and there might be in solution in the water sodium sulphate, potassium sulphate, magnesium sulphate, calcium sulphate, etc. The chemist cannot separate these various sulphates, but precipitates all the sulphuric acid present as the insoluble barium sulphate, which can be weighed and from which the sulphuric acid radicle (SO_3) is calculated. Thus, each basic and acid substance is separated, precipitated and weighed and reported as "found," although, strictly speaking, it is not found nor does it occur in that form in the water. This is frequently misunderstood by the person unacquainted with chemistry when looking over the reports of mineral water analyses. For instance, chlorine is constantly being reported as found in a mineral water. This does not mean, however, that the free irritant chlorine gas is there, but that chlorine combined with some basic radicle does occur in the mineral water.

In reporting the analyses, Dr. Venable says: "Two statements are made: first, the amounts of the basic and acid constituents found are given and then the probable compounds formed by these bodies. With regard to this last there is much lack of uniformity among chemists in spite of the appointment of various committees to devise some satisfactory system. Very little is actually known as to these compounds and various opinions seem to be held as to the relative probability of their formation. The chemical theories as to mass action look upon the acids as portioned out among all the bases in such a way as to bring about an equilibrium. This is probably true, but as we are ignorant as to the ratios in this apportionment, it is not possible to draw up such a list of compounds. The theory of solution, which is dominant in chemistry at present, supposes the existence of the acids and basic substance as separate bodies or negative and positive ions, not definitely united, yet with properties neutralized. In accord with this theory, the United States Geological Survey has adopted the system of simply reporting such and such ions as found. This system would be quite incomprehensible to the uninitiated public. They require something more definite and nearer their every-day experience than the reporting of sodium ions and chlorine ions and sulphuric acid ions as present in the water.

"In the following reports of analyses the chief guide followed was the general consideration of the most frequently met with compounds and hence the ones most likely to be met with or present. Thus, the chlorine was taken as combined with the sodium and, if there was any excess, with the potassium and the magnesium and calcium until the

amount of chlorine was exhausted. The sulphuric acid was combined with the potassium, and if in excess with the sodium, not united to the chlorine, and if there was still excess, then with the calcium. As there is excess of carbon in nearly all of these waters, the carbonates were all calculated as bicarbonates, thus giving the magnesium and calcium carbonate in a soluble form. It is generally believed that iron is present as ferric bicarbonate, and it is so reported. Certainly the iron is not present as ferric oxide, as is reported in many analyses.

"The phosphoric acid which is present, usually in traces only, is reported as combined with calcium as calcium phosphate. This is done in preference to sodium or potassium phosphate, often reported by chemists because the calcium phosphate is more abundant and widely distributed in the soil. No surmise is ventured as to which calcium is present, though it might be assumed that it is in the form of water-soluble or calcium hydrogen phosphate.

"The silica is simply reported as such. It is quite possible that it is present, sometimes as an alkaline silicate. No conjecture is ventured along this line either, and the usual custom is followed in reporting it simply as anhydrous silica."

THE UNIT OF MEASURE IN THE ANALYSES.

The results of the analyses of the mineral waters are given in three different ways: First, the compounds found are reported in the usual way for analytical work, but represent, instead of percentage, so many parts per 1,000,000 parts of water.

In the second and third methods a hypothetical form of combination has been made of the various compounds as they are supposed to exist in solution in the water and these compounds are reported in the second method in so many parts per 1,000,000 parts of water; that is, so many mg. in 1,000,000 mg. or a liter of water. Thus, 13.5 total solids per 1,000,000 would mean that there are 13.5 mg. of solid matter in 1,000,000 cm. or one liter of water.

In the third method the compounds are reported as so many grains in one gallon of water. To illustrate, if 2.5 grains of calcium chloride per gallon were reported, it would mean that in every gallon of the mineral water there were 2.5 grains of the salt, calcium chloride. This method is given for the reason that it is used to some extent by commercial dealers in reporting the composition of their mineral water. The second method is the one in most general use.

CLASSIFICATION OF MINERAL WATERS.

One of the first differences that is noted in mineral springs is in the temperature, and they are known as thermal or nonthermal springs according as the temperature is above or below 70° F.* In some of the hot springs the temperature rises to as high as 140° F., while in some of the nonthermal springs the temperature is as low as 39°. Waters from 70° F. to 98.6° F. would be considered warm or tepid, and those above 98.6° F. would be considered hot.

A number of systems have been advocated for the classification of mineral waters, and there is given below two which are very similar and which are considered the best. One, which was proposed by Mr. A. C. Peale,† is as follows:

PEALE'S CLASSIFICATION.

Thermal or Nonthermal.	I. Alkaline.	{ Sulphated. Muriated. Borated.	{ Sodie. Lithic. Potassic. Calcic. Magnesic. Chalybeate. Aluminous.	{ Nongaseous. Carbonated. Sulphureted. Azotized. Carbureted. Oxygenated.
	II. Alkaline-saline.			
	III. Saline.	{ Sulphated. Muriated. Borated.		
	IV. Acid.	{ Sulphated. Muriated. Silicious.		
		{ Sulphated. Muriated.		

The other classification, which was reported adopted by Mr. J. K. Haywood, Chemist of the U. S. Department of Agriculture,‡ is a modification of Peale's classification and is as follows:

HAYWOOD'S CLASSIFICATION.

Group.	Class.	Subclass.		
Thermal. Nonthermal.	I. Alkaline.	{ Carbonated or bicarbonated. Borated. Silicated.	{ Sodie. Lithic. Potassic. Calcic. Magnesic. Ferruginous. Aluminic. Arsenic. Bromic. Iodic. Silicious. Boric.	{ Nongaseous. Carbondioxated. Sulphureted. Azotized. Carbureted. Oxygenated.
	II. Alkaline-saline.	{ Sulphated. Muriated. Nitrated.		
	III. Saline.	{ Sulphated. Muriated. Nitrated.		
	IV. Acid.	{ Sulphated. Muriated.		

The chief differences between Peale's and Haywood's classifications are that the four classes of thermal and nonthermal waters, *i. e.*, alkaline-saline, saline, and acid, are defined not on the basis of combinations of ions present, as is done by Peale, but on the basis of the ions themselves, since no chemical methods are known by which we can determine

*Distinction used by Dr. A. C. Peale.

†A System of Physiologic Therapeutics, edited by S. S. Cohen, Vol. 9, p. 302.

‡U. S. Department of Agriculture, Bureau of Chemistry, Bull. No. 91, 1905, p. 9.

the relative amounts of the acid and basic ions entering into combinations with each other to form salts. Also, the alkaline group in the Haywood classification contains the carbonated, borated and silicated waters, since waters are known which owe their alkalinity, at least in part, to alkaline borates or silicates.

The alkaline-saline and saline groups have been divided into sulphated, muriated and nitrated waters, since Haywood has found at least one water which contained nitrate. Then again, in the Haywood classification, all the four groups are indicated as possible silicious waters instead of just the acid group.

It is possible from these classifications to name any mineral spring so that the name will give a fairly accurate idea of the chemical composition of the spring. When any basic element is very prominent in a mineral water, the name of this base can be prefixed to the regular class name as sodic, lithic, ferric, etc.

The following scheme will be of assistance in the naming of any mineral water according to the Haywood classification:

Thermal or Non-thermal.	{	Sodic.	{	Carbonated or bicarbonated.	{	Alkaline.	{	Arsenic.	{	Nongaseous. Carbon dioxide.	
		Lithic.		Borated.		Alkaline-saline.		Bromic.			
		Potassic.		Silicated.				Iodic.			
		Calcic.		Muriated.				Silicious.			
		Magnesian.		Nitrated.				Boric.			
		Ferruginous.		Sulphated.		Saline.		Lithic.			Sulphureted. Carbureted. Oxygenated.
		Aluminic.		Muriated.				Ferruginous.			
				Nitrated.				Etc.			
				Sulphated.		Acid.					
				Muriated.							

The commoner waters are:

Chalybeate waters.—Such waters as contain a notable proportion of a compound of iron, as ferrous bicarbonate, are properly called iron or chalybeate waters. This compound of iron is held in solution by the excess of carbonic acid in the waters. On bubbling up in a spring and coming in contact with the atmosphere this escapes as carbon dioxide and the ferrous carbonate is oxidized and changed to ferric hydroxide which is no longer soluble in the water and so is deposited as a red-brown slime in the spring or near its outlet. No matter how tightly stoppered a vessel of such a water may be, a deposit of ferric hydroxide will form in it on standing, and hence it does not bear transportation as well as other waters.

Sulphur waters.—These contain gaseous sulphureted hydrogen, hydrogen sulphide, in solution. This is supposed to come from the decomposition of certain metallic sulphides in the passage of the water through the soil. The presence of this gas reveals itself by the odor imparted to the water. The strength of the odor affords some indication as to the amount of sulphureted hydrogen present. Such waters

lose this gas, and consequently their odor, on bottling and shipping, etc., and, like the preceding class, do not bear transportation well. Many of these carry iron which is in the form of sulphate and so is not changed and deposited on standing like the ferrous bicarbonate.

Alum waters.—Some waters passing through alum shale dissolve more or less of the alum present. This imparts a very decided astringency to the water. Such waters generally contain a number of other sulphates, as those of iron and copper.

Alkaline waters.—These contain the carbonates and bicarbonates of sodium (sometimes potassium). This may be in sufficient amount to render the water strictly alkaline.

Saline waters.—Nearly all waters contain a small amount of sodium chloride or common salt. Where this predominates, or the proportions of it are exceptionally large, the water is called a saline water.

Lime waters.—Most waters contain a small amount of calcium bicarbonate. This gives to the water the property of hardness and causes the curdling or precipitation of soap. The degree of hardness is measured by the amount of calcium bicarbonate present. The effect is not very appreciable if only small amounts of it are present. Hard waters are very common in districts where there is much limestone. The presence of magnesium bicarbonate also adds to the hardness. As the hardness of such waters can be removed by boiling and other simple methods, they are said to be “temporarily hard.”

Where a water contains calcium sulphate it is called “permanently hard,” and no ordinary simple method will remove the hardness.

Magnesia waters.—The presence of magnesium chloride or magnesium sulphate (epsom salts) imparts a bitterness to the water. A large proportion of any compound of magnesium will give a magnesia water. The term is sometimes restricted to those in which magnesium bicarbonate is present.

THERAPEUTICS OF MINERAL WATERS.

It is impossible to trace the therapeutic action of each ingredient of the mineral water, for the small amount of these compounds present in the water seem to have a different action from what they do in specially prepared solutions. Some of the best results have been obtained where a very pure water has contained but one ingredient in large excess. Some of the chalybeate and sulphur springs of North Carolina are of this type, and they have proved to be most excellent waters. It is undoubtedly true, however, that the value of many of the so-called mineral waters depends largely upon their comparative

purity and the large quantities of them that invalids and others can be induced to drink while surrounded by conditions most generally favorable to rest and contentment.

In the following paragraphs there are given the physiological action and therapeutic applications of the various classes of mineral waters that have been brought together by the Bureau of Chemistry of the United States Department of Agriculture.* These results, however, were not obtained from experiments by the Bureau of Chemistry, but were taken from works which they considered authoritative on the subject.†

Carbonated or bicarbonated alkaline waters.—This is one of the most important groups of mineral waters. As a class these waters are used to stimulate the secretions of the digestive tract, neutralize superacidity of the stomach, dissolve uric acid, increase the flow of urine, and correct acidity of the urine. They are therefore of value in catarrhal conditions of the mucous membranes, rheumatism, gout, diabetes, etc.

Sodic carbonated and bicarbonated alkaline waters.—Sodium carbonate or bicarbonate appears as a normal constituent of the blood, lymph, and nearly all secretions of the mucous membrane. Where conditions arise that cause any of these fluids to become acid, this class of waters is of great value in counteracting the effect. The sodic carbonated waters increase metabolism, dissolve uric acid and allay irritation of the mucous membrane of the urinary tract. They have therefore been used with excellent results in treating acid dyspepsia, rheumatism, gout and diabetes.

Potassic carbonated and bicarbonated alkaline waters have very much the same action as the sodic carbonated, except that they are perhaps better for increasing the solubility and elimination of uric acid.

Lithic carbonated and bicarbonated alkaline waters.—While lithium seldom or never occurs in waters in large enough quantities to be a predominating basic constituent, still it does often appear in sufficient quantities to have a decided therapeutic action. These compounds are active diuretics and form a very soluble urate which is easily eliminated from the system. Waters of the above class, therefore, find their greatest application in the treatment of rheumatism, rheumatic tendencies and gout.

Magnesian carbonated and bicarbonated alkaline waters.—Such waters as these act as mild laxatives and are, perhaps, the best of all the car-

*Bulletin 91, Bureau of Chemistry, U. S. Department of Agriculture, Mineral Waters of the United States, by J. K. Haywood, 1905, page 12.

†Among these are Crook's Mineral Waters of the United States and Canada, Schweitzer's Mineral Waters of Missouri, and Cohen's System of Physiologic Therapeutics.

bonated alkaline waters in correcting an acid constipation. They favor the solution of uric acid and are used in catarrhal conditions of the mucous membrane of the urinary organs.

Calci carbonated and bicarbonated alkaline waters.—This class of waters is quite different in its effect from the carbonated waters previously mentioned. While the foregoing waters are evacuant and promote secretions, this class of waters constipates and decreases the secretions. Very obstinate cases of chronic diarrhœa have been cured by a sojourn at a spring rich in calcium bicarbonate.

Ferruginous bicarbonated alkaline waters.—These waters increase the amount of hæmoglobin and in connection therewith the temperature, pulse and weight. They also increase the appetite and reduce intestinal activity. Such waters give excellent results when used as a tonic. They find their principal application in anæmia and in general debility brought about by sexual diseases. Too long use of waters rich in iron results in constipation and derangement of the digestion.

Borated alkaline waters.—There are comparatively few springs of this description which have been used to any extent. Their therapeutic application, therefore, is somewhat obscure. It may be said in general that such waters act as anti-acids. Applied locally to catarrhal mucous membranes, they are of value.

Muriated alkaline-saline waters.—These waters are especially valuable in the treatment of catarrhal conditions of the mucous membrane of the stomach, intestines and biliary passages and urinary tract. They increase the flow of urine and the excretion of uric acid. The stronger ones are often used as a gargle.

Sulphated alkaline-saline waters.—These waters, like the preceding class, are valuable in the treatment of catarrhal conditions of the mucous membrane. They also act as diuretics. In large quantities they act as purgatives by increasing the peristaltic movement and liquefying the intestinal contents. Such waters as these are especially indicated in obesity.

Muriated saline waters.—As a whole these waters stimulate the secretion of the stomach, increase digestion, favor a more complete absorption of foods, and act as diuretics.

Sodic muriated saline waters.—When these waters are very heavily charged with sodium chloride they are often used for baths to increase the action of the skin, and by absorption act as a tonic. Such waters, when taken internally, are usually diluted. They increase the flow of gastric juice, improve the appetite, increase the flow of urine, and the urea in the same. They also prevent putrefactive changes in the intestines.

Potassic muriated saline waters.—It is not known whether there are waters which belong to the muriated saline group and yet contain potassium as a predominating constituent. However, potassium is sometimes present in these waters in considerable quantities. Its therapeutic action is very much like that of the sodium salt.

Lithic muriated saline waters.—Such waters as these would have the usual action of the muriated saline class, with an intensified diuretic effect, due to the lithium.

Calcic muriated saline waters.—These waters usually have sodium as the predominating basic constituent, along with notable amounts of calcium and sometimes magnesium. In general debility these waters act as a tonic. They increase the flow of urine and are used in the treatment of scrofulous diseases and eczema.

Sulphated saline waters.—As a class these waters are laxative or purgative, according to the quantity taken, and should generally only be used in moderate amounts. They are especially indicated where long continued stimulation of the intestinal activity is desired without stimulation of the vascular system.

Sodic and magnesic sulphated saline waters.—In small doses these waters act as laxatives and in large doses as purgatives. They increase the flow of the intestinal fluids and of the urine, the latter being accompanied by an increased elimination of urea. Such waters as these are of great service in eliminating syphilitic, scrofulous and malarial poisons from the system and in throwing off mercury and other metallic poisons. Persons suffering from obesity, dropsy, derangement of the liver, and Bright's disease are perhaps the most benefited by this class of waters.

Potassic sulphated saline waters.—While potassium may be present in large enough quantities in the sulphated saline waters to deserve mention, the authors do not know of any waters in which it is a predominating basic constituent. In so far as it is present, however, it has very much the same effect as the two salts mentioned above.

Calcic sulphated saline waters.—This class of waters forms what is known as the permanently hard group. They have no well-known therapeutic action.

Ferruginous sulphates saline waters and aluminic sulphated saline waters.—Iron and aluminum usually occur together when either is present as a predominating metallic constituent in sulphated saline waters. Since waters containing large quantities of iron and aluminum along with sulphuric acid ions are practically always acid, it is best to consider them under the sulphated acid group.

Nitrated saline waters.—The authors have only found one water which belongs to this class, and are undecided, on account of not being able to examine the surroundings of the spring, whether the nitrates are due to organic nitrogenous matter which is in active state of decomposition or to nitrogenous matter which has been oxidized in times long past and is therefore no longer injurious. In either case, however (especially in the latter), the existence of one water containing predominating quantities of nitrates necessitates a classification to cover this group of waters. The medicinal action of these waters has not been determined.

Acid waters.—This group of waters is principally composed of the ferruginous-aluminic sulphated class, although there are a few acid springs which contain comparatively little iron and aluminum, but quite large amounts of calcium, sodium or magnesium. These waters are used in relaxed conditions of the mucous membrane, especially when characterized by diarrhea or dysentery. They are also used in the treatment of exhausting night sweats and impoverished conditions of the body brought about by intemperance or specific diseases. Locally they are used in treating inflamed or relaxed conditions of the mucous membrane such as are found in conjunctivitis, chronic vaginitis, etc. The ferruginous waters of this group have the usual effect of all iron waters, such as has already been described under ferruginous carbonated alkaline waters. When a water is desired for its tonic effect it is best to give it in the ferruginous carbonated form, since it is more easily absorbed and assimilated.

Iodic and bromic waters.—Since iodine and bromine usually accompany each other in mineral waters, they should be considered together. Waters of this class act as alteratives. They stimulate the lymphatic system to greater activity and promote absorption in all the tissues. Their employment is therefore indicated in the treatment of scrofula, syphilis, goiter, chronic exudations, etc. They also favor the elimination of mercury and other metallic poisons. The bromic waters also act as sedatives.

Arsenic waters.—These waters act as an alterative, increase the appetite and digestion, and improve the whole nutrition of the body. They do this not only by increasing the secretion of the gastro-intestinal membrane, but also by checking katabolism. Such waters as these are especially valuable in the treatment of anæmia and a number of skin diseases. They are also indicated in the treatment of chronic malarial poisoning, neuralgia of anæmic origin, scrofulosis, etc.

Silicious waters.—The medicinal value of these waters has not been thoroughly investigated, although one or two investigations have been

made which seem to show that they would be of value in the treatment of cancer. It has been stated that silica taken internally has caused albumin and sugar to disappear from the urine.

Azotized and oxygenated waters.—Both nitrogen and oxygen are present in all waters that have come in contact with the air. On account of the limited solubility of both they cannot occur in waters in very large quantities. Neither of them as they occur in waters has any medicinal value.

Carbondioxated waters.—These waters contain free carbon dioxid as distinguished from the carbonated or bicarbonated waters which contain carbon dioxid in combination. Usually the heavily carbondioxated waters are also bicarbonated, but this is not necessarily true. Free carbon dioxid is present in practically all natural waters to some extent, but in some waters, notably the Saratoga, it is present in very large quantities. Such waters are extremely palatable, and large quantities can be drunk without causing a "full feeling." These waters tend to increase the flow of saliva and intestinal fluids, also to increase the peristaltic movements of the stomach and, therefore, increase digestion. They also tend to increase the flow of urine. Obstinate cases of nausea are often relieved by the use of this class of waters.

Carbureted waters.—These waters sometimes occur in coal and natural-gas regions. They are not known to have any medicinal value, but are usually considered unfit for drinking purposes.

Sulphureted waters.—These waters increase the action of the skin, intestines and kidneys. They also possess a decided alterative effect. They have been used in the treatment of syphilis, chronic metallic poisoning, rheumatism and gout. They have also given excellent results in many skin diseases.

LOCATION OF MINERAL SPRINGS.

In describing the mineral waters, those will be taken up first that occur in the eastern or coastal plain region, then those in the central or Piedmont plateau region, and finally those in the western or mountain region. It will be found that the distribution of the springs is quite irregular, that many are to be found in each region and also that the character of the spring varies according to the region in which it occurs. A short description is given first of the three physiographic regions into which the State is divided.

Coastal plain region.—This region represents the most recent geologic formations composed of gravels, sands, clays and marls arranged in nearly horizontal layers with the finer material nearer the coast. Along its eastern border this region contains the sounds and bays,

the sand dunes and ridges, the swamps and marshes, and other characteristics of a seashore region. Farther inland it is gently undulating and has more of the upland and less of the marsh, and towards its western boundary the swamps disappear almost entirely, the upland predominates and the surface becomes more undulating and even hilly in places. The soils toward the east are composed of fine sand and silt, while nearer the western border of the region they contain a larger proportion of coarse sand or gravel mingled with clay. The extent of this region is from Raleigh eastward to the coast, with its western boundaries roughly defined as extending from the western part of Northampton through Franklin, Wake, Cumberland, Chatham, Moore, Montgomery and Anson counties.

Along the western border of the coastal plain region there are occasional outcrops of hard granites and slates exposed along the beds of streams, where the once overlying sands and clays have been washed away. In the southeastern counties of this region limestone is exposed at the surface along the banks of streams in a large number of localities.

In this region the springs generally occur along the faces of steep slopes at the outcrop of coarse, sandy or gravelly strata. Chalybeate waters are not uncommon in portions of this region, due largely to the ferruginous character of these beds of gravel. Some of the deep wells yield saline waters owing to the fact that they have penetrated the strata carrying salt. Similarly, some of the deeper wells contain sulphur, due to the fact that these have penetrated tertiary or cretaceous strata which contain in places considerable quantities of decomposed pyrite or other sulphur compounds. The normal annual temperature of this coastal plain region is about 61° F. and the normal annual rainfall is about 55 inches.

Piedmont plateau region.—The Piedmont plateau region, extending westward from the coastal plain region to the mountain region, is about 125 miles in width and has an average elevation approximating 900 feet. Crossing this Piedmont plateau obliquely are a series of geologic formations which are in general parallel to the mountains and seashore. The most eastern of these formations is a narrow belt of triassic sandstone and shales which has a maximum width of about 15 miles, and extends from Oxford in Granville County across the State through portions of Wake, Durham, Chatham, Moore, Montgomery, Richmond and Anson counties. On the northeast of this sandstone and between it and the coastal plain region there are considerable areas of granite extending across portions of Wake, Franklin, Warren, Vance and Granville counties. To the west there is an older formation of metamorphosed slates and schists which cross through Person, Orange, Randolph,

Montgomery, Stanly and Union counties and has a general width of from 20 to 40 miles. Just west of this there is an area of granites, between which and the mountain region are gneisses, probably Archean. Near the western boundary of the Piedmont plateau region is the second of the two sandstone belts, which is much more limited in area than the one to the east and extends from the Virginia line across portions of Rockingham and Stokes counties, having a maximum width of from 4 to 5 miles.

There is a greater variety of mineral constituents in the waters of the springs of this region than in the coastal plain, owing to the greater variety of rocks and soils through which these waters percolate before becoming concentrated at certain places from which they reach the surface as springs. The average temperature of the Piedmont plateau region is about 58.5° F. and the annual rainfall is about 50 inches.

Mountain region.—The mountain region includes the Blue Ridge, Great Smokies and the country between, which is cut across by the numerous cross ranges separated by narrow valleys and deep gorges. The average elevation of this region is about 2,700 feet above the sea level, but the summits of many ridges and peaks are over 5,000 feet. A considerable number of peaks reach a height of over 6,000 feet, the highest of which is Mount Mitchell, with an elevation of 6,711 feet. Over the larger part of this region are to be found the older crystalline rocks, gneisses and granites, probably Archean, which are greatly folded and turned on their edges. On the western and eastern borders of this mountain region, approximately along the line of the Blue Ridge and Great Smokies, there are two narrow belts of younger rocks consisting of limestones, shales and conglomerates and the metamorphosed marbles, quartzites and slates.

In this region, as in the Piedmont plateau, the rocks are decayed to a considerable extent and thus have produced deep soils which vary in character according to the rocks from which they have been derived. The soils are for the most part porous and fertile, affording a luxuriant vegetation, in many places the slopes of the mountains being covered by heavy virgin forests. Where the rocks that have decomposed contained a large percentage of aluminous minerals, a large amount of clay has been formed, and such clay soils characterize a large portion of both the Piedmont and mountain regions.

The springs of the mountain region are similar to those of the Piedmont plateau. The average temperature for the region approximates 50° F., varying from 57.8° F. at Hot Springs, Madison County, to an estimated temperature for the summit of Mount Mitchell of less than 38° F. The normal annual precipitation is about 57 inches.

DESCRIPTION OF SPRINGS IN THE COASTAL PLAIN REGION.*

COWHEAD SPRING, NEAR WASHINGTON, BEAUFORT COUNTY.

The Cowhead Spring is located about 3 miles northeast of Washington, N. C., in a low, marshy space between two slight hills and also between the two prongs of a small stream which drains this area.

The flow of the spring was, at the time visited, about $10\frac{1}{2}$ gallons per minute and this is probably the minimum. There are evidences that the flow is quite variable and that at times the rate of flow is much greater than that measured. The sides of the receptacle into which the water rises are thinly coated with a flocculent deposit left by the water to a height of about one foot above the normal level, and as the discharge is through an opening in the side of the curbing, the discharge under this head would be considerably increased. This deposit varies in color from a bright yellow through various shades of yellow and orange to a dingy green. The water has a very perceptible odor and taste. When the temperature of the atmosphere was 15.6° C. in December, 1903, the temperature of the water was found to be 16.7° C.

ANALYSIS OF COWHEAD SPRING MINERAL WATER.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	1.10
Soda (Na_2O) -----	12.60
Lime (CaO) -----	16.90
Magnesia (MgO) -----	31.70
Ferric oxide (Fe_2O_3) -----	6.20
Manganese oxide (Mn_3O_4) -----	7.90
Sulphuric oxide (SO_3) -----	1.90
Chlorine (Cl) -----	7.40
Phosphoric oxide (P_2O_5) -----	.20
Silica (SiO_2) -----	49.50
Total solids at 110° C. -----	132.00

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	11.90	.69
Sodium sulphate (Na_2SO_4) -----	1.90	.11
Sodium bicarbonate ($HNaCO_3$) -----	17.90	1.04
Potassium sulphate (K_2SO_4) -----	1.90	.11
Potassium bicarbonate ($HKCO_3$) -----		
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	114.70	6.69
Calcium phosphate ($CaH_4(PO_4)_2$) -----	.50	.03
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	48.70	2.84
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	13.80	.81
Manganous bicarbonate ($Mn(HCO_3)_2$) -----	13.40	1.07
Silica (SiO_2) -----	49.50	2.87
Total grains per gallon -----		16.26

*Unless otherwise stated, analyses have been made by Dr. F. P. Venable.

HYGEIA SPRINGS, LITTLETON, HALIFAX COUNTY.

These springs are 1 mile north of Littleton, Halifax County, on the Seaboard Air Line Railway. One of these springs, No. 1, contains a much larger quantity of iron than the other and the iron oxide was the only constituent determined in this one.

ANALYSES OF HYGEIA SPRINGS MINERAL WATER.

No. 621.

Name and Formula.	Parts per 1,000,000.	
	No. 1.	No. 2.
Soda (Na_2O) -----		.80
Potash (K_2O) -----		4.50
Lime (CaO) -----		3.20
Magnesia (MgO) -----		1.00
Ferric oxide (Fe_2O_3) -----	14.00	4.50
Manganese oxide (Mn_2O_3) -----		.50
Sulphuric oxide (SO_3) -----		.40
Chlorine (Cl) -----		5.50
Silica (SiO_2) -----		23.70
Total solids at 110°C . -----	41.50	60.00

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Miligrams in 1,000,000 Parts of Water.	Grains per Gallon.
Sodium chloride (NaCl) -----	10.50	.61
Potassium sulphate (K_2SO_4) -----	1.40	.08
Magnesium bicarbonate ($\text{Mg}(\text{HCO}_3)_2$) -----	3.60	.21
Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$) -----	9.30	.54
Ferrous bicarbonate ($\text{Fe}(\text{HCO}_3)_2$) -----	10.00	.58
Manganous bicarbonate ($\text{Mn}(\text{HCO}_3)_2$) -----	1.20	.07
Silica (SiO_2) -----	23.70	1.38
Total grains per gallons -----		3.47

LAWRENCE SPRINGS, NEAR MURFREESBORO, HERTFORD COUNTY.

There are two of these springs, No. 1 and No. 2, which are $11\frac{1}{2}$ miles from Murfreesboro by road, but a shorter distance in a direct line. Spring No. 2 is 200 yards due west of No. 1. Spring No. 1 has a flow of about 2 gallons per minute, and No. 2 of about 6 gallons per minute.

ANALYSES OF LAWRENCE SPRINGS MINERAL WATER.

No. 110.

Name and Formula.	Parts per 1,000,000.	
	No. 1.	No. 2.
Potash (K_2O)	trace	.90
Soda (Na_2O)	3.20	4.60
Lime (CaO)	5.20	7.10
Magnesia (MgO)	4.00	1.90
Manganese oxide (Mn_2O_3)	3.80	2.50
Ferric oxide (Fe_2O_3)	1.60	2.20
Sulphuric oxide (SO_3)	16.60	10.50
Chlorine (Cl)	4.00	6.40
Phosphoric oxide (P_2O_5)	trace	
Silica (SiO_2)	23.80	20.20
Total solids at $110^\circ C.$	78.00	68.00

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	No. 1.		No. 2.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	6.00	.35	8.70	.51
Potassium sulphate (K_2SO_4)			1.60	.10
Magnesium chloride ($MgCl_2$)			1.70	.09
Magnesium sulphate ($MgSO_4$)	12.00	.69		
Magnesium bicarbonate ($Mg(HCO_3)_2$)			4.30	.25
Calcium sulphate ($CaSO_4$)	12.60	.74	6.10	.96
Calcium phosphate ($CaH_4(PO_4)_2$)	trace	trace	trace	trace
Ferrous bicarbonate ($Fe(HCO_3)_2$)	3.50	.20	5.00	.29
Manganous bicarbonate ($Mn(HCO_3)_2$)	8.50	.52	5.90	.34
Silica (SiO_2)	23.80	1.38	20.20	1.17
Total grains per gallon		3.88		3.71

FAIRGROUNDS SPRING, MURFREESBORO, HERTFORD COUNTY.

This spring is within the corporate limits of the town of Murfreesboro, which is situated on a bluff above the Herrin River and about 250 yards of the main street. It was formerly known as the Wise Spring. The spring has a flow of about 2 gallons per minute.

ANALYSIS OF FAIRGROUNDS SPRING MINERAL WATER.

No. 712.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	1.30
Soda (Na_2O)	28.10
Lime (CaO)	9.10
Magnesia (MgO)	2.90
Ferric oxide (Fe_2O_3)	1.90
Manganese oxide (Mn_2O_3)	4.60
Sulphuric oxide (SO_3)	5.60
Phosphoric oxide (P_2O_5)	trace
Chlorine (Cl)	18.20
Silica (SiO_2)	20.90
Total solids at $110^\circ C.$	80.60

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)-----	29.90	1.74
Sodium sulphate (Na_2SO_4)-----	8.40	.49
Sodium bicarbonate ($\text{Na}(\text{HCO}_3)$)-----	36.30	2.11
Potassium sulphate (K_2SO_4)-----	2.20	.13
Magnesium bicarbonate ($\text{Mg}(\text{HCO}_3)_2$)-----	10.50	.59
Calcium phosphate ($\text{CaH}_4(\text{PO}_4)_2$)-----	trace	trace
Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$)-----	26.20	1.53
Ferrous bicarbonate ($\text{Fe}_2(\text{HCO}_3)_2$)-----	4.20	.25
Manganous bicarbonate ($\text{Mn}(\text{HCO}_3)_2$)-----	10.40	.59
Silica (SiO_2)-----	20.90	1.22
Total grains per gallon-----		8.65

CATHERINE LAKE SPRING, ONSLOW COUNTY.

This spring is in Onslow County, about 10 miles west of Jacksonville, and is $1\frac{1}{2}$ miles southwest of Catherine Lake. The water flows from the foot of a low hill and rises in a pool enclosed by a wooden box (about 7 x 18 feet) with a roof over it. The water in this pool is 4 feet deep and overflows in a stream about 6 feet wide and $1\frac{1}{4}$ inches deep at the rate of 1,500 gallons per minute. The temperature of the water was 17°C . with an air temperature of 24°C .

ANALYSIS OF CATHERINE LAKE SPRING
MINERAL WATER.

No. 728.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	.60
Soda (Na_2O)-----	4.30
Lime (CaO)-----	21.70
Magnesia (MgO)-----	6.20
Ferric oxide (Fe_2O_3)-----	3.10
Manganese oxide (Mn_3O_4)-----	2.50
Sulphuric oxide (SO_3)-----	6.50
Chlorine (Cl)-----	6.20
Phosphoric oxide (P_2O_5)-----	.10
Silica (SiO_2)-----	21.50
Total solids at 110°C .-----	115.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)-----	8.10	.47
Potassium sulphate (K_2SO_4)-----	1.30	.08
Magnesium chloride (MgCl_2)-----	2.60	.15
Magnesium bicarbonate ($\text{Mg}(\text{HCO}_3)_2$)-----	19.60	1.14
Calcium phosphate ($\text{CaH}_4(\text{PO}_4)_2$)-----	.30	.02
Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$)-----	62.40	3.64
Ferrous bicarbonate ($\text{Fe}(\text{HCO}_3)_2$)-----	6.90	.40
Manganous bicarbonate ($\text{Mn}(\text{HCO}_3)_2$)-----	5.80	.34
Silica (SiO_2)-----	21.50	1.26
Total grains per gallon-----		7.50

ELLERBE SPRING, RICHMOND COUNTY.

This spring is in Richmond County 12 miles north of Rockingham. It is in a grove of oaks at the base of a hill on the south side of a creek. There are buildings to accommodate guests. The spring is enclosed with masonry and covered. The water forms in the outflow a heavy reddish-brown flocculent deposit. The water is charged with carbon dioxide, escaping bubbles of which can be noticed. It has no odor. The rate of flow is about 1 gallon per minute and a half and the temperature in the summer of 1897 was 60.8° F. (16° C.)

ANALYSIS OF ELLERBE SPRING MINERAL WATER.

No. 670.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	2.00
Soda (Na_2O)-----	5.40
Lime (CaO)-----	20.70
Magnesia (MgO)-----	7.60
Ferric oxide (Fe_2O_3)-----	4.60
Manganese oxide (Mn_2O_4)-----	1.00
Sulphuric oxide (SO_3)-----	4.80
Chlorine (Cl)-----	6.00
Phosphoric oxide (P_2O_5)-----	2.60
Silica (SiO_2)-----	29.60
Total solids at 110° C.-----	145.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	10.20	.59
Potassium sulphate (K_2SO_4)-----	3.70	.22
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	27.70	1.60
Calcium phosphate ($CaH_4(PO_4)_2$)-----	.60	.04
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	59.80	3.91
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	8.80	.51
Manganous bicarbonate ($Mn(HCO_3)_2$)-----	2.30	.13
Silica (SiO_2)-----	29.60	1.73
Total grains per gallon-----	-----	8.73

RED SPRINGS, ROBESON COUNTY.

Near Red Springs station, in Robeson County, on the Fayetteville and Bennettsville branch of the Atlantic Coast Line Railway, 12 miles south of Fayetteville, there are numerous flowing wells and springs, the water from which is mildly chalybeate and leaves a reddish deposit of iron oxide where it discharges. The flowing wells or "springs," as they are generally called, are located from a third to half a mile north of the railway station. Half a dozen iron pipes have been driven to a

depth of 20 to 25 feet, where they penetrate the water-bearing gravels and sands, and up through these the water rises to a height of from 1 to 3 feet above the ground surface and flows at the rate of from one-half gallon to 2 gallons per minute. The water has generally a slight hydrogen-sulphide odor and a mild chalybeate taste, and its source is sufficiently deep to render it safe from ordinary surface contamination.

Located on the east side of these springs is the Red Springs Female Seminary, and on the west side is an academy for boys. Near-by hotels and boarding houses furnish ample accommodations for visitors.

Samples of water for analyses were collected in July, 1896, of water flowing from the iron pipes at springs Nos. 2 and 6, and the result of these analyses are given below.

ANALYSES OF RED SPRINGS MINERAL WATER.

Nos. 647 and 648.

Name and Formula.	Parts Per 1,000,000.	
	No. 2.	No. 6.
Potash (K_2O)	29.50	.30
Soda (Na_2O)	3.80	2.20
Lime (CaO)	2.50	2.50
Magnesia (MgO)	2.20	1.30
Ferric oxide (Fe_2O_3)	7.50	7.10
Manganese oxide (Mn_2O_4)	2.10	
Sulphuric oxide (SO_2)	1.90	1.50
Chlorine (Cl)	8.00	4.40
Hydrogen sulphide (H_2S)	trace	
Silica (SiO_2)	13.00	13.40
Total solids at $110^{\circ}C$.	102.00	47.00

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	No. 2.		No. 6.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	7.50	.43	4.30	.25
Potassium chloride (KCl)	7.50	.43	.50	.03
Potassium sulphate (K_2SO_4)	4.40	.25		
Potassium bicarbonate ($KHCO_3$)	43.30	2.52		
Magnesium bicarbonate ($Mg(HCO_3)_2$)	8.00	.46	4.80	.28
Calcium bicarbonate ($Ca(HCO_3)_2$)	7.30	.42		
Calcium chloride ($CaCl_2$)			2.90	.17
Calcium sulphate ($CaSO_4$)			2.10	.12
Calcium phosphate ($CaH_2(PO_4)_2$)	trace	trace		
Ferrous bicarbonate ($Fe(HCO_3)_2$)	16.50	.96	15.80	.92
Manganous bicarbonate ($Mn(HCO_3)_2$)	5.10	.29		
Silica (SiO_2)	13.00	.75	13.40	.78
Total grains per gallon		6.52		2.55

Red Springs No. 2 is located on the west side of the railway, about 300 yards north of the Townsend Hotel. The water as it flows from an iron pipe about 2 feet above ground at the rate of about 1 gallon

per minute has a slight hydrogen-sulphide odor and an iron taste. Its temperature was found to be 64° F. (July, 1896).

Red Spring No. 6.—This spring is about 100 yards north of spring No. 2 (page 94) and has the same general surroundings. It is a strong, bold spring, flowing about 4 gallons per minute. The temperature (July, 1896) was 62° F. Water is shipped both from this and spring No. 2.

PANACEA SPRING, WARREN COUNTY.

This spring is located at Panacea Springs, Warren County, about 4 miles south of Littleton, a station on the Seaboard Air Line Railway. The spring has been known since the first settlement of that section of the State and it has been supposed that the Indians valued the water for its medicinal purpose from the fact that the solid rock was hollowed out, forming a crude round basin for holding the water. It has been used by the white settlers almost continuously since it was discovered and hundreds of visitors have been visiting this spring regularly each year. There are ample hotel accommodations (see Pl. VII, A) for guests located near the spring. The new Panacea Hotel, which was built in 1908, contains 100 rooms, each of which is equipped with steam heat, lighted by electricity, and has hot and cold running water. The grounds run in connection with it cover something like 20,000 acres, a portion of which has been made into a lake covering 40 acres (see Pls. VII, B, and VIII, A), which is equipped with rowboats and canoes and well stocked with game fish. The park is headquarters for the Mosby Hall Hunt Club.

The location and equipment of the Panacea Spring Company make the place a most attractive one for the tourist as well as for those who wish to avail themselves of the spring water for medicinal purposes.

The main spring, which flows from crevices in the rock, has been carefully protected and a large basin hollowed out for holding a supply of water. A neat pavilion has been built over the spring (Pl. VIII, B). This water is being bottled and put on the market in cases of 12 half-gallon bottles. The flow of the spring is 8 gallons per minute. The waters are chalybeate and charged with a considerable amount of carbon dioxide gas. There is a deposit of iron oxide such as is usually observed from springs of this class. A complete analysis was made of the water of this spring.

Thirty yards below the dam of the first spring is another chalybeate spring (II), but only the total solids and ferric oxide were determined in the water. One hundred and twenty-five yards southwest of spring No. 1 is spring No. 8, which is also strongly chalybeate. Only total solids and ferric oxide were determined in the waters of this spring.

ANALYSES OF PANACEA SPRINGS MINERAL
WATER.

Nos. 622, 623, 624.

Name and Formula.	Parts per 1,000,000.		
	No. 1.	No. 2.	No. 8.
Potash (K_2O)	1.20	-----	-----
Soda (Na_2O)	4.70	-----	-----
Lime (CaO)	7.00	-----	-----
Magnesia (MgO)	3.60	-----	-----
Ferric oxide (Fe_2O_3)	11.50	2.80	1.30
Manganese oxide (Mn_2O_3)	4.00	-----	-----
Sulphuric oxide (SO_3)	.30	-----	-----
Chlorine (Cl)	5.50	-----	-----
Silica (SiO_2)	14.90	-----	-----
Total solids at 110° C.	107.50	9.50	7.25

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	10.20	.59
Potassium chloride (KCl)	1.10	.06
Potassium sulphate (K_2SO_4)	.70	.04
Magnesium bicarbonate ($Mg(HCO_3)_2$)	13.10	.76
Calcium bicarbonate ($Ca(HCO_3)_2$)	20.20	1.18
Ferrous bicarbonate ($Fe(HCO_3)_2$)	25.60	1.49
Manganous bicarbonate ($Mn(HCO_3)_2$)	9.60	.52
Silica (SiO_2)	14.90	.87
Total grains per gallon		5.51

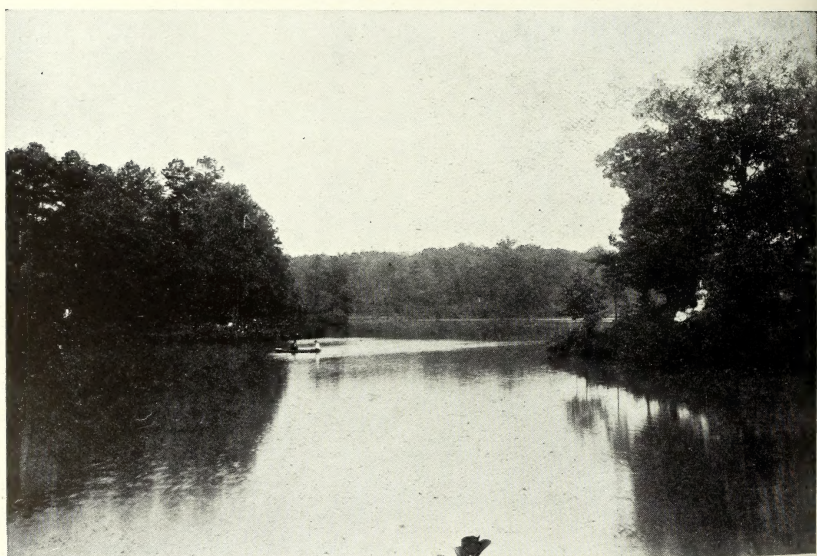
SEVEN SPRINGS, WAYNE COUNTY.

The Seven Springs mineral springs are situated in Wayne County near the right bank of the Neuse River, about 9 miles southwest of LaGrange station on the A. and N. C. Railroad. The name applied to these springs originated in the fact that they are seven in number and within a space of about 10 x 15 feet. The volume of water flowing from the several springs varies from 3 gallons per minute from the boldest spring (No. 1) to less than 1 gallon per minute from spring No. 7. The temperature of the water in the several springs, probably varying with the rate of flow of the water, ranges from 16.9° C. to 18° C. The temperature of the air at the time these measurements were taken was 29.9° C.

The location of the springs is only a few yards back of the river bank, on a terrace from 1 to 200 yards wide and just above the high-water mark of severe freshets. One hundred to 150 yards back of the springs the surface rises rapidly to a height of from 60 to 80 feet above the river to a still higher terrace which merges into the general surface of the country. The front of this upper terrace has been cut into



A, NEW PANACEA HOTEL, PANACEA SPRINGS, WARREN COUNTY, N. C.



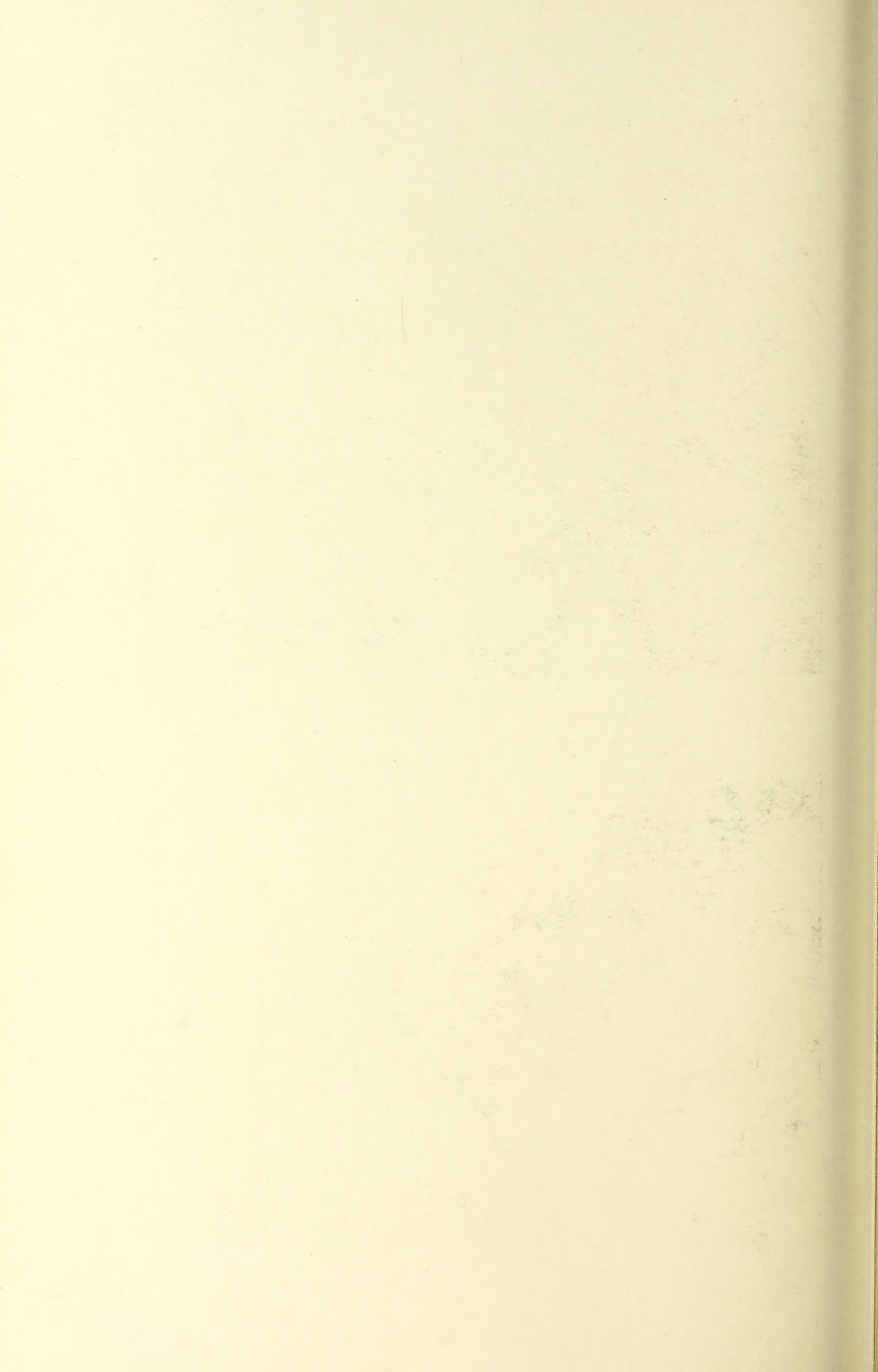
B, LAKE COVERING FORTY ACRES, PANACEA SPRINGS, WARREN COUNTY, N. C.



A, LAKE AND SPRING-HOUSE, PANACEA SPRINGS, WARREN COUNTY, N. C.



B, SPRING-HOUSE, PANACEA SPRINGS, WARREN COUNTY, N. C.



rugged forms through the eroding action of the small branches and the rains in such a way as to give an exceedingly picturesque appearance to the region. Hotel accommodations have been provided on the upper terrace only a couple of hundred yards from the springs.

ANALYSES OF SEVEN SPRINGS MINERAL WATERS.

Nos. 736, 737, 738, 739, 740, 741, 742.

Name and Formula.	Parts per 1,000,000.						
	Spring No. 1.	Spring No. 2.	Spring No. 3.	Spring No. 4.	Spring No. 5.	Spring No. 6.	Spring No. 7.
Potash (K ₂ O) -----	.6	.8	1.2	1.4	.6	.9	.6
Soda (Na ₂ O) -----	4.7	4.0	6.1	4.2	3.7	4.0	3.7
Lime (CaO) -----	3.9	3.5	2.7	2.4	3.8	3.8	4.0
Magnesia (MgO) -----	1.5	1.7	1.5	2.1	1.6	1.5	1.8
Ferric oxide (Fe ₂ O ₃) -----	5.0	3.7	2.4	4.5	2.0	2.6	6.4
Manganese oxide (Mn ₃ O ₄) -----	trace	-----	-----	trace	trace	-----	-----
Sulphuric oxide (SO ₃) -----	9.0	9.7	7.7	9.2	9.9	9.4	10.3
Chlorine (Cl) -----	5.4	4.6	7.0	4.8	4.2	4.6	4.2
Phosphoric oxide (P ₂ O ₅) -----	trace	trace	trace	trace	trace	-----	trace
Silica (SiO ₂) -----	14.9	14.4	15.4	14.9	13.7	12.9	16.6
Total solids at 110° C. -----	46.0	50.0	50.0	47.0	40.0	40.0	47.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.						
	Spring No. 1.	Spring No. 2.	Spring No. 3.	Spring No. 4.	Spring No. 5.	Spring No. 6.	Spring No. 7.
Sodium chloride (NaCl) -----	8.9	7.6	11.5	7.9	6.9	7.6	6.9
Potassium sulphate (K ₂ SO ₄) -----	1.1	1.4	2.2	2.6	1.1	1.7	1.1
Calcium sulphate (CaSO ₄) -----	9.5	8.5	6.6	5.8	9.4	9.2	9.8
Calcium phosphate (CaH ₄ (PO ₄) ₃) -----	trace	trace	trace	trace	trace	trace	trace
Magnesium sulphate (MgSO ₄) -----	5.5	5.6	4.6	6.7	5.4	4.8	5.8
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	11.1	8.1	5.3	9.9	4.4	5.7	14.1
Manganese bicarbonate (Mn(HCO ₃) ₂) -----	trace	-----	-----	trace	trace	-----	-----
Silica (SiO ₂) -----	14.9	14.4	15.4	14.9	13.7	12.9	16.6

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Grains per Gallon.						
	Spring No. 1.	Spring No. 2.	Spring No. 3.	Spring No. 4.	Spring No. 5.	Spring No. 6.	Spring No. 7.
Sodium chloride (NaCl) -----	.519	.443	.671	.460	.402	.443	.402
Potassium sulphate (K ₂ SO ₄) -----	.064	.082	.128	.152	.064	.099	.064
Calcium sulphate (CaSO ₄) -----	.554	.495	.384	.338	.584	.537	.572
Calcium phosphate (CaH ₄ (PO ₄) ₃) -----	trace	trace	trace	trace	trace	trace	trace
Magnesium sulphate (MgSO ₄) -----	.321	.327	.268	.391	.315	.280	.338
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	.589	.472	.309	.577	.257	.332	.822
Manganese bicarbonate (Mn(HCO ₃) ₂) -----	trace	-----	-----	trace	trace	-----	-----
Silica (SiO ₂) -----	.868	.840	.898	.868	.790	.752	.969
Total grains per gallon -----	2.915	2.659	2.658	2.786	2.412	2.443	3.167

DESCRIPTION OF SPRINGS IN THE PIEDMONT PLATEAU.

HEALING SPRINGS, CABARRUS COUNTY.

These springs, two in number, are 17 miles from Lexington, Davidson County. One is a sulphur and the other a chalybeate spring. The chalybeate spring has a flow of $3\frac{1}{2}$ gallons per minute and a temperature of 15.6° C. The water comes out from rocks beside a small branch at the foot of a hill.

The sulphur spring has no smell of hydrogen sulphide and but little sediment. The flow was about one-half gallon per minute and the temperature 16.6° C. Little care was taken of the spring and there were no accommodations for guests. The two springs are about 15 feet apart in the same ledge of rock.

ANALYSES OF HEALING SPRINGS MINERAL WATER.

Nos. 678 and 625.

Name and Formula.	Parts per 1,000,000.	
	Sulphur Spring.	Chalybeate Spring.
Potash (K_2O) -----	.6	.3
Soda (Na_2O) -----	13.7	11.4
Lime (CaO) -----	51.0	40.5
Magnesia (MgO) -----	10.6	7.9
Ferric oxide (Fe_2O_3) -----	1.1	3.2
Manganese oxide (Mn_2O_4) -----		2.9
Sulphuric oxide (SO_3) -----	7.0	7.4
Chlorine (Cl) -----	5.6	6.0
Phosphoric oxide (P_2O_5) -----		trace
Silica (SiO_2) -----	43.9	42.1
Total solids at 110° C. -----	175.0	180.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Sulphur Spring.		Chalybeate Spring.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	9.2	.54	9.8	.57
Sodium sulphate (Na_2SO_4) -----	11.5	.67	13.7	.80
Sodium bicarbonate ($NaHCO_3$) -----	10.6	.62		
Potassium sulphate (K_2SO_4) -----	1.1	.06	.5	.03
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	38.7	2.26	28.8	1.68
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	147.4	8.60	116.8	6.81
Calcium phosphate ($CaH_4(PO_4)_2$) -----	trace	trace	trace	trace
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	2.4	.14	7.1	.41
Manganous bicarbonate ($Mn(HCO_3)_2$) -----			6.6	.39
Silica (SiO_2) -----	43.9	2.56	42.1	2.46
Total grains per gallon -----		15.45		13.15

STRADER'S SPRING, PELHAM, CASWELL COUNTY.

This spring is owned by G. W. Strader, Pelham, N. C., and is situated about $2\frac{1}{2}$ miles northwest of the town. It comes up into a

stone basin, but is not taken care of now. This has never been a place where health seekers came, but years ago was a place for campers and picnickers. The temperature of the water is 14.8° C., with an air temperature of 32.8° C. The flow of the spring is about one-half gallon per minute. The water has no decided odor or taste, but is slightly milky in appearance. There are no houses near the spring.

ANALYSIS OF STRADER'S SPRING MINERAL WATER.
No. 723.

Name of Formula.	Parts per 1,000,000.
Potash (K_2O) -----	2.3
Soda (Na_2O) -----	10.4
Lime (CaO) -----	23.9
Magnesia (MgO) -----	9.4
Ferric oxide (Fe_2O_3) -----	3.8
Sulphuric oxide (SO_3) -----	3.6
Chlorine (Cl) -----	2.4
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	42.0
Total solids at 110° C. -----	136.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	3.9	.23
Sodium sulphate (Na_2SO_4) -----	2.9	.17
Sodium bicarbonate ($NaHCO_3$) -----	20.1	1.17
Potassium sulphate (K_2SO_4) -----	4.2	.25
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	34.0	1.98
Calcium phosphate ($CaH_4(PO_4)_3$) -----	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	68.8	4.01
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	8.5	.49
Silica (SiO_2) -----	42.0	2.45
Total grains per gallon -----		10.75

PARKS SPRING, CASWELL COUNTY.

This spring is located 6 miles east of Pelham. The water has quite an extensive use all through the surrounding country and as far as Danville, Va. The temperature of the water is 14.8° C. when the air temperature is 26° C. The flow is about one-half gallon per minute. The water is very cool, clear, and tastes well, leaving a slightly bitter after taste in the mouth. It has no perceptible odor and does not show any escaping gases. The spring comes up beside a small creek into a section of terra-cotta pipe and is kept very well and clean. There are no accommodations for guests.

ANALYSIS OF PARKS SPRING MINERAL WATER.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	1.6
Soda (Na_2O)	14.1
Lime (CaO)	33.7
Magnesia (MgO)	4.9
Ferric oxide (Fe_2O_3)	3.3
Manganese oxide (Mn_2O_4)	2.7
Sulphuric oxide (SO_3)	7.6
Chlorine (Cl)	3.6
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	45.4
Total solids at $110^{\circ} C$	198.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	5.8	.34
Sodium sulphate (Na_2SO_4)	11.3	.65
Sodium bicarbonate ($NaHCO_3$)	16.5	.96
Potassium sulphate (K_2SO_4)	2.9	.17
Magnesium bicarbonate ($Mg(HCO_3)_2$)	17.7	1.01
Calcium phosphate ($CaH_2(PO_4)_2$)	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	96.9	5.65
Ferrous bicarbonate ($Fe(HCO_3)_2$)	7.3	.43
Manganous bicarbonate ($Mn(HCO_3)_2$)	6.3	.37
Silica (SiO_2)	45.4	2.65
Total grains per gallon		12.23

CATAWBA SPRING, CATAWBA COUNTY.

This spring is located at Catawba Springs, 8 miles from Hickory, the nearest station on the Southern Railway. The spring has been developed and accommodations provided for guests by the Catawba Springs Hotel Company. The location is delightful and the place is patronized as a summer resort.

ANALYSIS OF CATAWBA SPRING MINERAL WATER.

No. 682.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	3.2
Soda (Na_2O)	34.9
Lime (CaO)	3.9
Magnesia (MgO)	1.9
Ferric oxide (Fe_2O_3)	1.1
Sulphuric oxide (SO_3)	3.5
Phosphoric oxide (P_2O_5)	trace
Chlorine (Cl)	10.6
Silica (SiO_2)	20.5
Total solids at $110^{\circ} C$	128.0



A, VIEW AT MOUNT VERNON SPRINGS, N. C.



B, HOTEL AT MOUNT VERNON SPRINGS, N. C.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	17.5	1.03
Sodium sulphate (Na ₂ SO ₄) -----	1.8	.10
Sodium bicarbonate (NaHCO ₃) -----	67.8	3.95
Potassium sulphate (K ₂ SO ₄) -----	5.9	.34
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	6.9	.40
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	11.3	.65
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	2.4	.14
Silica (SiO ₂) -----	20.5	1.19
Total grains per gallon -----		7.80

MOUNT VERNON SPRINGS, ORE HILL, CHATHAM COUNTY.

These springs are situated about 1¼ miles from the Ore Hill station on the Cape Fear and Yadkin Railroad. There are ample hotel accommodations for guests and the grounds are improved (Pls. IX, A and B). The springs are two in number and about 3 feet apart and 3 and 4 feet deep down to solid rock. They are carefully enclosed and well kept. The flow of the springs is 1 and 1½ gallons, respectively.

ANALYSES OF MOUNT VERNON SPRINGS MINERAL

No. 605.

WATER.

Name and Formula.	Parts per 1,000,000.	
	Spring No. 1.	Spring No. 2.
Potash (K ₂ O) -----	2.0	-----
Soda (Na ₂ O) -----	15.6	-----
Lime (CaO) -----	160.5	-----
Magnesia (MgO) -----	6.6	-----
Ferric oxide (Fe ₂ O ₃) -----	.8	-----
Sulphuric oxide (SO ₃) -----	84.3	-----
Chlorine (Cl) -----	16.0	16.0
Phosphoric oxide (P ₂ O ₅) -----	trace	-----
Silica (SiO ₂) -----	25.4	-----
Total solids at 110° C. -----	485.0	470.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	30.	1.75
Sodium sulphate (Na ₂ SO ₄) -----	4.6	.27
Potassium sulphate (K ₂ SO ₄) -----	.6	.03
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	24.0	1.40
Calcium sulphate (CaSO ₄) -----	138.2	8.06
Calcium phosphate (CaH ₄ (PO ₄) ₃) -----	trace	trace
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	299.0	17.45
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	1.8	.10
Silica (SiO ₂) -----	25.4	1.48
Total grains per gallon -----		30.54

There was no deposit observed and the water is clear and without odor. The sample was taken July 5, 1895. The temperature ranges about 15.5° C. The water is for sale in 5 and 10-gallon carboys and in 1-pint and half-gallon bottles.

PATTERSON SPRING, NEAR SHELBY, CLEVELAND COUNTY.

This spring is 4 miles south of Shelby and is well kept. It flows one-third of a gallon per minute and the temperature observed in July, 1896, was 20° C. The water gives off an odor of hydrogen sulphide.

ANALYSIS OF PATTERSON SPRING MINERAL WATER.
No. 654.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	2.2
Soda (Na ₂ O) -----	10.4
Lime (CaO) -----	28.3
Magnesia (MgO) -----	4.7
Ferric oxide (Fe ₂ O ₃) -----	.6
Sulphuric oxide (SO ₃) -----	5.9
Chlorine (Cl) -----	11.2
Silica (SiO ₂) -----	29.1
Total solids at 110° C. -----	132.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	19.0	1.10
Sodium sulphate (Na ₂ SO ₄) -----	1.6	.09
Potassium sulphate (K ₂ SO ₄) -----	3.9	.22
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	17.2	1.00
Calcium sulphate (CaSO ₄) -----	5.6	.32
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	75.4	4.39
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	1.3	.07
Silica (SiO ₂) -----	29.1	1.69
Total grains per gallon -----		8.88

M'BRAYER SPRING, CLEVELAND COUNTY.

This spring is about 4 miles northwest of Shelby and is beside the same branch on which the Lithia Spring is located. The spring has quite an extensive reputation and is said to be the first one discovered in this county and has been known for many years. The water is said to be equal to that of Cleveland or Patterson's springs. The spring flows out of the side of the hill and into a stone basin.

There was formerly a hotel here, but for a good many years past it has been allowed to fall into decay and is nearly uninhabitable. The temperature of the water is 16.4° C. and the flow is about 11½ gallons per minute. The odor and taste of sulphur is very perceptible.

ANALYSIS OF McBRAYER SPRING MINERAL
WATER.

No. 718.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	3.5
Soda (Na_2O)	15.0
Lime (CaO)	20.7
Magnesia (MgO)	4.5
Ferric oxide (Fe_2O_3)	.1
Sulphureted hydrogen (H_2S)	.2
Sulphuric oxide (SO_3)	3.0
Phosphoric oxide (P_2O_5)	trace
Chlorine (Cl)	6.0
Silica (SiO_2)	24.3
Total solids at $110^{\circ} C.$	96.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	9.7	.58
Sodium bicarbonate ($NaHCO_3$)	26.8	1.56
Potassium sulphate (K_2SO_4)	6.5	.38
Magnesium bicarbonate ($Mg(HCO_3)_2$)	16.3	.95
Calcium phosphate ($CaH_4(PO_4)_3$)	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	59.5	3.47
Ferrous bicarbonate ($Fe(HCO_3)_2$)	.2	.01
Sulphureted hydrogen (H_2S)	.2	.01
Silica (SiO_2)	24.3	1.42
Total grains per gallon		8.38

CLEVELAND SULPHUR SPRINGS, CLEVELAND COUNTY.

These springs, 3 in number, are close together and are located 2 miles southeast of Shelby, Cleveland County. The more prominent and better known one is the White Sulphur Spring, which is well kept and has a natural rock bottom. The flow of the spring is 2 gallons per minute and its temperature in 1896 was $18^{\circ} C$. The water has a decided odor of hydrogen sulphide.

The second spring, known as Red Sulphur Spring, has a flow of 1 gallon per minute and a temperature of $16.8^{\circ} C$. (summer of 1896). It has a decided odor and taste of hydrogen sulphide.

The third spring, known as the Iron Spring, has a flow considerably less than 1 gallon per minute and a temperature but little below that of the atmosphere. The water is strongly chalybeate, as is seen from the analysis below.

There are no special arrangements for visitors at these springs and guests find hotel accommodations at Shelby. These springs have been known and used for over half a century, but only within recent years

have the waters been brought prominently before the public. In the following table there is given the analysis of each of these springs:

ANALYSES OF CLEVELAND SULPHUR SPRINGS MINERAL WATER.

Nos. 655, 638 and 685.

	Parts per 1,000,000.		
	White Sulphur Spring.	Red Sulphur Spring.	Iron Spring.
Potash (K_2O)-----	2.6	3.9	3.5
Soda (Na_2O)-----	11.6	11.5	6.2
Lime (CaO)-----	31.1	21.6	8.6
Magnesia (MgO)-----	7.3	4.5	4.5
Ferric oxide (Fe_2O_3)-----	1.5	1.2	14.4
Manganese oxide (Mn_2O_3)-----	trace		3.1
Sulphuric oxide (SO_3)-----	4.9	4.6	.4
Phosphoric oxide (P_2O_5)-----		trace	trace
Chlorine (Cl)-----	13.2	5.0	7.0
Silica (SiO_2)-----	31.0	25.3	29.7
Total solids at $110^0 C$.-----	135.0	113.0	102.0

HYPOTHETICAL FORM OF COMBINATION.

Nos. 655, 638 and 685.

Name and Formula.	White Sulphur Spring.		Red Sulphur Spring.		Iron Spring.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium sulphate (Na_2SO_4)-----			2.3	.13		
Sodium chloride ($NaCl$)-----	22.4	1.31	8.2	.48	11.5	.67
Sodium bicarbonate ($NaHCO_3$)-----			6.5	.96		
Potassium sulphate (K_2SO_4)-----	4.7	.27	7.2	.42	6.5	.38
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	26.7	1.56	16.4	.96	16.4	.96
Calcium sulphate ($CaSO_4$)-----	4.9	.28				
Calcium phosphate ($CaH_4(PO_4)_3$)-----			trace	trace		
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	84.4	4.92	67.2	3.91	24.9	1.45
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	3.3	.19	2.6	.15	31.8	1.85
Manganous bicarbonate ($Mn(HCO_3)_2$)-----	trace	trace			7.3	.44
Silica (SiO_2)-----	31.0	1.81	25.3	1.47	27.9	1.63
Total grains per gallon-----		10.34		8.48		7.38

CLEVELAND MILLS SULPHUR SPRING, CLEVELAND COUNTY.

About 12 miles south of Shelby, between the two Cleveland cotton mills, on the bank of Maple Creek near its confluence with the first Broad River, there is a small sulphur spring known as "The Sulphur Spring." It is largely used in the neighborhood as a tonic water and has the reputation of some cures. The spring is totally unimproved, but is kept clean and is much visited by picnic parties. There are no accommodations for guests nearer than Cleveland Mills, and the only house near it is a mill house about 100 yards up the creek. The spring water rises into a wooden box about 1 foot square from a low place

about 10 feet from the creek bank, and flows at the rate of about 1 gallon per minute and has a temperature of 14.8° C. (58.4° F.). The water has a slight smell and taste of hydrogen sulphide.

ANALYSIS OF COTTON MILLS SULPHUR SPRING
MINERAL WATER.

No. 726.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	3.6
Soda (Na_2O) -----	8.2
Lime (CaO) -----	33.2
Magnesium (MgO) -----	4.8
Ferric oxide (Fe_2O_3) -----	.7
Sulphuric oxide (SO_3) -----	7.0
Chlorine (Cl) -----	3.2
Sulphureted hydrogen (H_2S) -----	.3
Silica (SiO_2) -----	31.0
Total solids at 110° C. -----	128.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	5.2	.30
Sodium sulphate (Na_2SO_4) -----	6.8	.40
Sodium bicarbonate ($NaHCO_3$) -----	5.3	.31
Potassium sulphate (K_2SO_4) -----	6.6	.38
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	19.6	1.14
Calcium phosphate ($CaH_4(PO_4)_2$) -----	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	95.6	5.58
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	1.6	.09
Sulphureted hydrogen (H_2S) -----	.3	.02
Silica (SiO_2) -----	31.0	1.80
Total grains per gallon -----		10.02

SHELBY LITHIA SPRING, CLEVELAND COUNTY.

This spring is 3 miles north of Shelby. The water is brought in iron pipes to a fountain on the courthouse square, where it is for sale.

ANALYSIS OF SHELBY LITHIA SPRING MINERAL WATER.

No. 684.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	2.7
Soda (Na_2O) -----	8.1
Lime (CaO) -----	24.5
Magnesia (MgO) -----	4.8
Ferric oxide (Fe_2O_3) -----	.4
Manganese oxide (Mn_2O_3) -----	1.3
Sulphuric oxide (SO_3) -----	5.7
Chlorine (Cl) -----	1.8
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	25.1
Total solids at 110° C. -----	123.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	2.9	.17
Sodium sulphate (Na ₂ SO ₄) -----	6.0	.35
Sodium bicarbonate (NaHCO ₃) -----	7.9	.46
Potassium sulphate (K ₂ SO ₄) -----	5.0	.29
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	17.5	1.02
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	7.8	4.13
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	.8	.05
Manganous bicarbonate (Mn(HCO ₃) ₂) -----	2.8	.16
Silica (SiO ₂) -----	25.1	1.47
Total grains per gallon -----		8.10

The flow is about 1 gallon per minute and the temperature 15.4° C. The water smells strongly of hydrogen sulphide. The sample was drawn from the spring late in the summer of 1897.

MINERAL SPRINGS AT WINSTON-SALEM, FORSYTH COUNTY.

The Old Salem Spring.—This spring is situated on the outskirts of the town of Salem, about one-half mile southwest from the center of the town and quite near to the railway. Its water has been used for a number of years and it has quite a local reputation. The spring is neatly enclosed and kept clean. It has a faint odor of hydrogen sulphide and is to be classed among the weak sulphur springs. It is also strongly impregnated with iron and there is an iron deposit in the outflow. The spring is not an old one.

South Side Park Spring.—This is located about 1 mile south of Winston-Salem in one of the city parks. The spring is enclosed in a terra-cotta pipe which is sunk around it. There are no other improvements. The flow is moderate and the temperature is about 15.5° C.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Old Salem Spring.		South Side Park Spring.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	7.8	.45	2.6	.15
Potassium chloride (KCl) -----	5.6	.33	1.1	.06
Potassium sulphate (K ₂ SO ₄) -----	.5	.03	.9	.05
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	15.3	.89	5.7	.33
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	25.5	1.49	9.0	.52
Calcium phosphate (CaH ₄ (PO ₄) ₃) -----			trace	trace
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	98.8	5.76	1.3	.08
Hydrogen sulphide (H ₂ S) -----	weak	weak		
Silica (SiO ₂) -----	12.8	.75	15.6	.91
Total grains per gallon -----		9.70		2.10

MARIENBAD SPRINGS, FORSYTH COUNTY.

These springs are situated 2 miles from Winston in a northwesterly direction on the slope of a hill. They are 14 in number and within a few feet of each other. The side of the hill has been cut back and the springs enclosed in large terra-cotta pipes sunk in around them. Most of them are clear, without odor and deposit. One has a slight odor of hydrogen sulphide and one forms a deposit of ferric hydroxide. There are no sources of contamination near the springs and the water is remarkably pure. There are abundant hotel accommodations. The water is delivered also to customers in Winston. The samples were taken in July, 1895. A full analysis is given of spring No. 5 and partial analyses of the remaining springs.

ANALYSIS OF MARIENBAD SPRING, No. 5.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	.6
Soda (Na_2O) -----	1.4
Lime (CaO) -----	4.4
Magnesia (MgO) -----	1.9
Ferric oxide (Fe_2O_3) -----	.7
Sulphuric oxide (SO_3) -----	.2
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	19.7
Total solids at 110° C. -----	47.5

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	2.9	.17
Potassium chloride (KCl) -----	.5	.03
Potassium sulphate (K_2SO_4) -----	.5	.03
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	5.2	.30
Calcium phosphate ($CaH_4(PO_4)_3$) -----	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	12.5	.73
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	1.6	.09
Silica (SiO_2) -----	19.7	1.15
Total grains per gallon -----		2.50

TOTAL SOLIDS IN MARIENBAD SPRINGS, NEAR
WINSTON, FORSYTH COUNTY.

Nos. 608, 620.

Spring.	Parts per 1,000,000.	Spring.	Parts per 1,000,000.
No. 1 -----	40.	No. 8 -----	50.
No. 2 -----	50.	No. 9 -----	75.
No. 3 -----	47.5	No. 10 -----	50.
No. 4 -----	45.0	No. 11 -----	42.5
No. 5 -----	47.5	No. 12 -----	40.
No. 6 -----	37.5	No. 13 -----	40.
No. 7 -----	45.	No. 14 -----	40.

ALL HEALING SPRINGS, GASTON COUNTY.

These springs are between 4 and 5 miles from Bessemer City. The springs are four in number, the one called "All Healing" being the one most used and was the only one sampled. The other springs are known as "Iron," "Sulphur" and "Union." All are covered in with brickwork and the outflow is through pipes. The flow of all is slight. The water of the All Healing Spring is odorless, but has a slight taste. The summer temperature is 15.6° C. (60° F.).

ANALYSIS OF ALL HEALING SPRING MINERAL WATER.

No. 681.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	.6
Soda (Na_2O) -----	2.4
Lime (CaO) -----	3.5
Magnesia (MgO) -----	2.0
Ferric oxide (Fe_2O_3) -----	.4
Sulphuric oxide (SO_3) -----	4.9
Chlorine (Cl) -----	2.8
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	8.9
Total solids at 110° C. -----	57.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	4.6	.27
Potassium sulphate (K_2SO_4) -----	1.1	.06
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	7.3	.43
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	10.1	.58
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	.8	.05
Silica (SiO_2) -----	8.9	.52
Total grains per gallon -----		1.91

BUCKHORN LITHIA SPRING, GRANVILLE COUNTY.

More water is shipped from the Buckhorn Lithia Spring at the present time than from any other spring in North Carolina and it is very rapidly acquiring favor, and wherever used it has been very highly commended. It is about 10 miles north of Oxford and 1 mile from Bullock, a small station on the Southern Railway. The spring is located on the side of a hill that rises gradually to a height of about 40 feet above the stream bed. The water flows from crevices in the solid rock and was discovered in 1904 by two sons of Mr. B. T. Hicks, on whose land the spring was located. The boys in drinking the water noticed its peculiar character, and speaking of this, it soon attracted



A, COUNTRY HOME FOUR HUNDRED YARDS FROM BUCKHORN LITHIA SPRINGS, WHERE MANY VISITORS TO THE SPRINGS ARE ENTERTAINED.



B, BUCKHORN LITHIA SPRING AND BOTTLING PLANT.

the attention of others. In September, 1905, it was purchased by a stock company and early in 1906 the company began to ship the water. There are no hotel accommodations for guests at the springs, but there was a large country house that has been arranged for the accommodation of guests who wish to stop at the springs (see Pls. X, A and B). The flow of the spring is approximately $1\frac{1}{2}$ gallons per minute.

Upon analysis the water was found to contain a decidedly noticeable percentage of lithia. A complete analysis by Mr. Donald L. Liddell, of Johns Hopkins University, gave the following results, the report being made in the hypothetical form of combination of the constituents:

ANALYSIS* OF BUCKHORN LITHIA MINERAL WATER.

Name and Formula.	Grains per Gallon.
Sodium chloride (NaCl) -----	.61
Sodium sulphate (Na ₂ SO ₄) -----	.34
Sodium bicarbonate (NaHCO ₃) -----	.38
Potassium chloride (KCl) -----	.06
Lithium bicarbonate (LiHCO ₃) -----	4.71
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	2.57
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	9.7
Iron oxide (Fe ₂ O ₃) -----	.18
Aluminum oxide (Al ₂ O ₃) -----	.18
Silica (SiO ₂) -----	1.6
Total grains per gallon -----	20.15

*Donald L. Liddell, Analyst.

CRESWELL SPRING, IREDELL COUNTY.

This spring is 2 miles in a southerly direction from Mooresville. Its waters have been used for medicinal purposes since 1794. At one time it was much visited by families from Charlotte and other neighboring towns, who built a number of cottages near by. It is still used by persons in the neighborhood.

ANALYSIS OF CRESWELL SPRING MINERAL WATER.

No. 631.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	4.
Soda (Na ₂ O) -----	14.9
Lime (CaO) -----	54.7
Magnesia (MgO) -----	3.7
Ferric oxide (Fe ₂ O ₃) -----	1.8
Sulphuric oxide (SO ₃) -----	26.9
Chlorine (Cl) -----	4.0
Phosphoric oxide (P ₂ O ₅) -----	trace
Silica (SiO ₂) -----	91.4
Total solids at 110° C. -----	315.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	7.5	.44
Sodium sulphate (Na ₂ SO ₄) -----	26.1	1.52
Potassium sulphate (K ₂ SO ₄) -----	7.4	.43
Magnesium bicarbonate (Mg (HCO ₃) ₂) -----	13.5	.79
Calcium bicarbonate (Ca (HCO ₃) ₂) -----	140.8	8.21
Calcium sulphate (Ca ₂ SO ₄) -----	20.7	1.21
Ferrous bicarbonate (Fe (HCO ₃) ₂) -----	4.0	.23
Silica (SiO ₂) -----	91.4	5.33
Total grains per gallon -----		18.16

The spring is neatly enclosed and the water is clear and odorless. The flow is one-half gallon per minute and the temperature at the time of taking the sample (July, 1895) was 15.5° C.

BARIUM SPRINGS, IREDELL COUNTY.

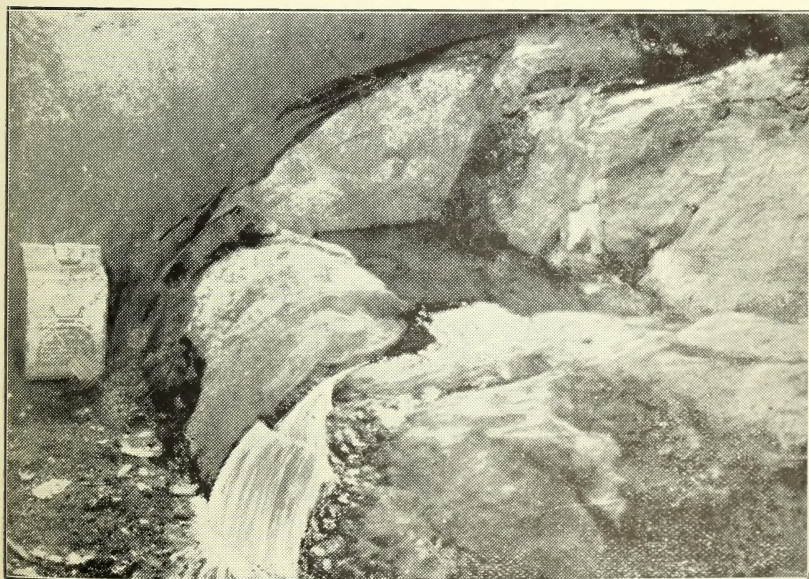
The celebrated Barium Springs are located a short distance from Barium Springs station on the Southern Railway, 5 miles south of Statesville and about one-half mile west of the Presbyterian Orphanage. There are a series of 9 springs in the group, known as follows:

1. Barium Rock Spring.
2. Potash White Sulphur Spring.
3. Alkaline Calcic Spring.
4. Sulpho Calcic Spring.
5. Saline Chalybeate Spring.
6. Chalybeate Spring.
7. Magnesia.
8. Saline.
9. Chalybeate.

Of these springs the Barium Rock Spring (Pl. XI, A) is the one that has called special attention to the group and is the one that is used the most. It is also the only water that is being bottled and shipped, and a considerable business has been built up in the shipment of this water. This is another one of the springs of the State whose discovery is attributed to the Indians, who are supposed to have realized its medicinal value and to have made pilgrimages to it. It has been used locally for a great many years, and recently the property has been improved and a hotel of 40 rooms erected for the accommodation of guests, and bottling works established. The Barium Rock Spring issues from the side of a rock, as shown in Plate XI, B, and has a flow of about 1½ gallons per minute. The basin for holding the water is cut into the rock and has a capacity of about 375 gallons. The temperature of the spring



A, BARIUM ROCK SPRING, BARIUM SPRINGS, N. C.



B, CELEBRATED ROCK SPRING, AT BARIUM SPRINGS, N. C.

is approximately that of the atmosphere. A complete analysis has been made of the Barium Rock Spring water and a qualitative analysis of a number of the others, the results of which are given below:

ANALYSIS OF BARIUM SPRING MINERAL WATER.

No. 632.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	3.8
Soda (Na_2O)	13.4
Lime (CaO)	39.8
Magnesia (MgO)	5.2
Ferric oxide (Fe_2O_3)	1.4
Sulphuric oxide (SO_3)	8.8
Chlorine (Cl)	5.5
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	31.8
Total solids at $110^{\circ} C$.	193.5

HYPOTHETICAL FORM OF COMBINATION.

No. 632.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	10.3	.60
Sodium sulphate (Na_2SO_4)	9.9	.58
Sodium bicarbonate ($NaHCO_3$)	10.0	.58
Potassium sulphate (K_2SO_4)	7.0	.41
Magnesium bicarbonate ($Mg(HCO_3)_2$)	15.3	.89
Calcium phosphate ($CaH_4(PO_4)_3$)	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	115.1	6.71
Ferrous bicarbonate ($Fe(HCO_3)_2$)	3.1	.18
Silica (SiO_2)	31.8	1.85
Total grains per gallon		11.80

The Chalybeate Spring was tested by W. A. Withers, of the North Carolina Department of Agriculture, and gave: Total solids, 7.2 grains per gallon. It showed the presence of: Soda (Na_2O); potash (K_2O); magnesia (MgO); lime (CaO); iron oxide (Fe_2O_3); chlorine (Cl); carbon dioxide (CO_2).

White Sulphur Spring was also tested by Mr. W. A. Withers, of the State Department of Agriculture, and gave: Total solids, 10.5 grains per gallon, and showed the presence of: Soda (Na_2O); potash (K_2O); magnesia (MgO); lime (CaO); iron oxide (Fe_2O_3); chlorine (Cl); sulphuric oxide (SO_3), and carbonic oxide (CO_2).

The Red Sulphur Spring, tested by Mr. W. A. Withers, gave: Total solids, 10.4 grains per gallon, and showed the presence of: Soda (Na_2O); potash (K_2O); magnesia (MgO), lime (CaO); iron oxide (Fe_2O_3); chlorine (Cl); sulphuric oxide (SO_3); carbonic oxide (CO_2).

EUPEPTIC SPRINGS, IREDELL COUNTY.

These springs (of which there are several) are situated 15 miles north of Statesville. They were at one time used to a considerable extent locally for medicinal purposes, but they are now little used and unimproved.

ANALYSIS OF EUPEPTIC SPRING MINERAL WATER.

No. 633.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	1.5
Soda (Na_2O)-----	11.2
Lime (CaO)-----	24.4
Magnesia (MgO)-----	5.4
Ferric oxide (Fe_2O_3)-----	.8
Sulphuric oxide (SO_3)-----	15.5
Chlorine (Cl)-----	5.0
Phosphoric oxide (P_2O_5)-----	trace
Silica (SiO_2)-----	24.8
Total solids at $110^{\circ} C$.-----	122.5

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	9.4	.55
Sodium sulphate (Na_2SO_4)-----	12.2	.71
Potassium sulphate (K_2SO_4)-----	2.7	.16
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	19.7	1.15
Calcium sulphate (Ca_2SO_4)-----	15.2	.88
Calcium phosphate ($CaH_4(PO_4)_3$)-----	-----	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	52.4	3.06
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	1.7	.10
Silica (SiO_2)-----	24.8	1.45
Total grains per gallon-----	-----	8.06

LINCOLN LITHIA SPRING, LINCOLN COUNTY.

This spring is located $1\frac{1}{2}$ miles from the town of Lincolnton, Lincoln County. The lithia spring is located about the center of a tract of 225 acres of land. There is a hotel situated very close to the spring known as Lithia Inn, which has accommodations for 60 guests. As a result of the popularity of this mineral water and its location in the heart of the Piedmont section, a club known as the Lincoln Lithia Club has recently been organized which has purchased the grounds, hotel, spring and bottling works of the old company and has been incorporated. Its object is to provide a country estate and promote and cultivate social intercourse, games and physical exercises amongst its members. It will have all the equipment and be governed in practically the same way as the various country clubs scattered throughout the

State. Although this makes the spring and property come under the regulations of a club, the bottling works will be continued and the water shipped as formerly.

The flow of the spring is approximately 1 gallon per minute and the temperature is 60° F. A chemical analysis reported by the company gave the following results, the constituents being given in a hypothetical form of combination:

ANALYSIS LINCOLN LITHIA SPRING MINERAL WATER—
HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.
Potassium sulphate (K_2SO_4) -----	16.21
Sodium chloride ($NaCl$) -----	14.01
Sodium bicarbonate ($NaHCO_3$) -----	2.58
Sodium phosphate -----	trace
Lithium bicarbonate ($LiHCO_3$) -----	33.6
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	8.15
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	76.36
Calcium sulphate ($CaSO_4$) -----	12.71
Iron bicarbonate ($Fe(HCO_3)_2$) -----	2.67
Alumina (Al_2O_3) -----	trace
Silica (SiO_2) -----	7.8

MIDA MINERAL SPRING, MECKLENBURG COUNTY.

The Mida Mineral Spring is located in the historic county of Mecklenburg 10 miles northwest of Charlotte. It is one of the springs recently discovered, but since that time it has become well known and is now being put on the market by the Sample Mineral Water Company, of Charlotte. There are no hotel accommodations for guests, although more or less of the water is used locally. It is purely a ship-

ANALYSIS OF THE MIDA SPRING MINERAL WATER—
HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	.209
Sodium sulphate (Na_2SO_4) -----	.190
Sodium bicarbonate ($NaHCO_3$) -----	1.170
Sodium nitrate ($NaNO_3$) -----	.320
Potassium Sulphate (K_2SO_4) -----	.052
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	4.135
Calcium phosphate ($CaH_4(PO_4)_2$) -----	.034
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	1.955
Lithium bicarbonate ($LiHCO_3$) -----	.005
Iron bicarbonate ($Fe(HCO_3)_2$) -----	.015
Aluminum hydroxide ($Al(OH)_3$) -----	.005
Manganese bicarbonate ($Mn(HCO_3)_2$) -----	trace
Barium bicarbonate ($Ba(HCO_3)_2$) -----	trace
Zinc bicarbonate ($Zn(HCO_3)_2$) -----	trace
Silica (SiO_2) -----	3.426
Total grains per gallon -----	11.525

ping business. The flow of the spring is about 2 gallons per minute and the temperature 60° F. An analysis of this water was made by Prof. Robert C. Price and the results, which were reported in a hypothetical form of combination, are given on page 113.

MONTGOMERY SULPHUR SPRING, MONTGOMERY COUNTY.

This spring is situated 3 miles south of Candor. It has a very small flow—only 1 gallon in every ten minutes—and the temperature is but little above that of the atmosphere. There is an odor of hydrogen sulphide. The water is strongly alkaline and the spring uncared for.

ANALYSIS OF MONTGOMERY SULPHUR SPRING MINERAL WATER.

No. 669.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	8.5
Soda (Na_2O)	82.5
Lime (CaO)	3.9
Magnesia (MgO)	.8
Ferric oxide (Fe_2O_3)	1.7
Manganese oxide (Mn_2O_4)	1.9
Sulphuric oxide (SO_3)	13.2
Chlorine (Cl)	18.2
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	14.8
Total solids at 110° C.	218.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	30.0	.59
Sodium sulphate (Na_2SO_4)	.7	.62
Sodium bicarbonate ($NaHCO_3$)	7.5	10.35
Potassium sulphate (K_2SO_4)	5.7	.92
Magnesium bicarbonate ($Mg(HCO_3)_2$)	2.9	.17
Calcium phosphate ($CaH_4(PO_4)_2$)		trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	1.3	.65
Ferrous bicarbonate ($Fe(HCO_3)_2$)	3.8	.22
Manganous bicarbonate ($Mn(HCO_3)_2$)	4.2	.25
Silica (SiO_2)	4.8	.86
Total grains per gallon		14.63

JACKSON SPRINGS, MOORE COUNTY.

These springs are located at Jackson Springs, a station on the Ashboro and Aberdeen Railroad in the southwestern corner of Moore County, a short distance from the Montgomery line and 11 miles from the famous resort, Pinehurst, N. C. The spring has been known for a great many years and its reputation continued to grow until, in 1890,

there was sufficient demand for the accommodation of people visiting the springs to warrant the erection of a small hotel for their accommodation, and it was filled to overflowing the first season. The hotel accommodations have been increased constantly since that time until now there is a three-story building with 64 sleeping rooms (see Plate XII, A), which is equipped with all modern conveniences, such as hot and cold water, steam heat and electric lights. Surrounding the hotel is a park containing 800 acres of rolling land, a large part of which is covered with long-leaf pine, hickory and oak. A lake (Pl. XII, B) has also been built in the park which offers splendid fishing, boating and bathing. It has been stocked with black bass. Although the medicinal value of the Barium Spring waters is well known and a great deal of the water is shipped for this purpose, the management have not attempted to make this simply a health resort, but, on the other hand, have combined all those features of a resort that make it attractive to tourists and the pleasure-seeker, and there is no doubt but that this place does combine health and rest with pleasure.

The water of these two springs bubbles up from underneath a huge rock (diabase)—one at the rate of about 2 gallons per minute and the other somewhat less. It is the latter one that is used and the temperature of its water is 15.3°C . (58.5°F). The water is bottled quite extensively and shipped. An analysis has been made of this water by Mr. H. B. Battle, who was formerly director of the North Carolina Agricultural Experiment Station. The results of the analysis are given below, where the constituents have been reported in their hypothetical form of combination:

ANALYSIS OF JACKSON SPRINGS MINERAL WATER.

No. 668.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	2.6
Soda (Na_2O)-----	12.8
Lime (CaO)-----	16.6
Magnesia (MgO)-----	6.6
Ferric oxide (Fe_2O_3)-----	5.1
Manganese oxide (Mn_2O_3)-----	2.8
Sulphuric oxide (SO_3)-----	7.0
Chlorine (Cl)-----	6.8
Phosphoric oxide (P_2O_5)-----	trace
Silica (SiO_2)-----	39.2
Total solids at 110°C .-----	142.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	11.2	.65
Sodium sulphate (Na ₂ SO ₄)	8.5	.50
Potassium sulphate (K ₂ SO ₄)	4.8	.28
Sodium bicarbonate (NaHCO ₃)	8.7	.51
Magnesium bicarbonate (Mg(HCO ₃) ₂)	24.1	1.41
Calcium bicarbonate (Ca(HCO ₃) ₂)	45.8	2.67
Calcium phosphate (CaH ₄ (PO ₄) ₂)	trace	trace
Ferrous bicarbonate (Fe(HCO ₃) ₂)	11.3	.66
Manganous bicarbonate (Mn(HCO ₃) ₂)	6.4	.37
Silica (SiO ₂)	39.2	2.29
Total grains per gallon		9.34

EAGLE SPRINGS, MOORE COUNTY.

These springs are situated 1 mile southwest of Eagle Springs station, on the Aberdeen and West End Railroad. The chief spring is in sandy ground near a small stream. The flow is one-half a gallon per minute and the temperature (summer of 1897) was 15.6° C. There are no improvements except a small terra-cotta pipe enclosing the spring and a small summer house near by. The water is used locally.

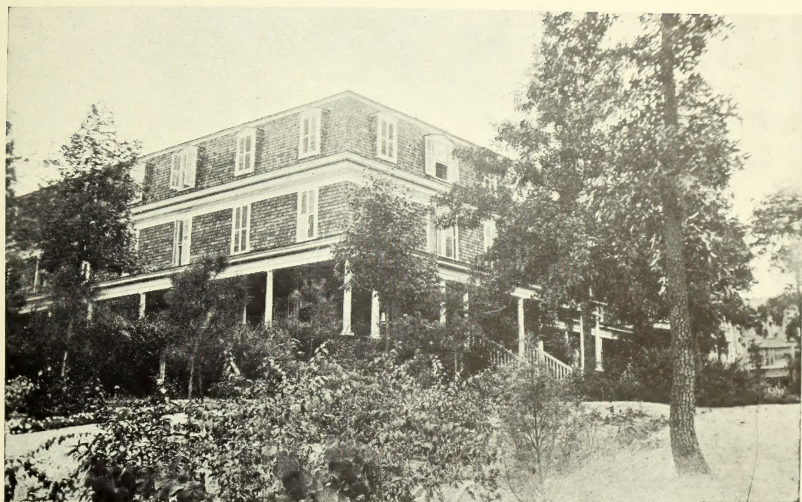
ANALYSIS OF EAGLE SPRINGS MINERAL WATER.

No. 671.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O)	2.5
Soda (Na ₂ O)	24.1
Lime (CaO)	13.7
Magnesia (MgO)	4.1
Ferric oxide (Fe ₂ O ₃)	2.5
Sulphuric oxide (SO ₃)	11.6
Chlorine (Cl)	5.0
Phosphoric oxide (P ₂ O ₅)	.7
Silica (SiO ₂)	30.5
Total solids at 110° C.	118.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	8.2	.48
Sodium sulphate (Na ₂ SO ₄)	16.9	.99
Sodium bicarbonate (NaHCO ₃)	33.6	1.96
Potassium sulphate (K ₂ SO ₄)	4.6	.27
Magnesium bicarbonate (Mg(HCO ₃) ₂)	14.9	.87
Calcium bicarbonate (Ca(HCO ₃) ₂)	39.9	2.32
Ferrous bicarbonate (Fe(HCO ₃) ₂)	5.5	.32
Silica (SiO ₂)	30.5	1.78
Total grains per gallon		8.99



A, JACKSON SPRINGS HOTEL, JACKSON SPRINGS, N. C.



B, THE LAKE, JACKSON SPRINGS, N. C.

LEMON SPRING, MOORE COUNTY.

This spring is situated about $2\frac{1}{2}$ miles from Lemon Springs station on the Seaboard Air Line Railway. The spring is well kept and issues from a terra-cotta pipe sunk into the ground. It is clear and without odor and flows at the rate of one-half gallon per minute. The temperature at the time the sample was taken (July, 1896) was 18° C. (64.4° F.)

ANALYSIS OF LEMON SPRING MINERAL
WATER.

No. 652.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	.7
Soda (Na_2O) -----	15.1
Lime (CaO) -----	71.4
Magnesia (MgO) -----	4.9
Ferric oxide (Fe_2O_3) -----	.7
Manganese oxide (Mn_2O_3) -----	.7
Sulphuric oxide (SO_3) -----	5.2
Chlorine (Cl) -----	7.4
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	42.9
Total solids at 110° C. -----	188.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	12.6	.73
Sodium sulphate (Na_2SO_4) -----	8.5	.49
Sodium bicarbonate ($NaHCO_3$) -----	7.5	.49
Potassium sulphate (K_2SO_4) -----	1.1	.06
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	17.9	1.04
Calcium phosphate ($CaH_4(PO_4)_2$) -----	trace	-----
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	207.1	12.08
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	1.5	.09
Manganous bicarbonate ($Mn(HCO_3)_2$) -----	1.6	.09
Silica (SiO_2) -----	42.9	2.50
Total grains per gallon -----	-----	17.57

STROWD CHALYBEATE SPRING, ORANGE COUNTY.

This spring is situated about one-half mile northeast of Chapel Hill, within a few hundred yards of the Durham road. It has been cleaned out but has not been otherwise improved. It is used locally. There is a considerable deposit of iron hydroxide and basic carbonate in the outflow. The water has a decided iron taste. The flow is about one-half gallon per minute and the temperature in the summer is 15.5° C.

ANALYSIS OF STROWD CHALYBEATE SPRING
MINERAL WATER.

No. 606.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	.8
Soda (Na_2O)-----	7.1
Lime (CaO)-----	9.1
Magnesia (MgO)-----	13.8
Ferric oxide (Fe_2O_3)-----	81.5
Sulphuric oxide (SO_3)-----	1.1
Chlorine (Cl)-----	8.0
Phosphoric oxide (P_2O_5)-----	trace
Silica (SiO_2)-----	23.6
Total solids at $110^\circ C$.-----	180.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	13.2	.77
Potassium sulphate (K_2SO_4)-----	1.5	.09
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	44.4	2.59
Calcium phosphate ($CaH_4(PO_4)_2$)-----	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	26.3	1.53
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	181.3	10.57
Silica (SiO_2)-----	23.6	1.38
Total grains per gallon-----		16.93

TYSON SPRING, ORANGE COUNTY.

This spring is 6 miles from Chapel Hill and within a few hundred yards of the crossing of the Chapel Hill-Oxford road and the Hillsboro-Raleigh road. It is a strong, bold spring and the water has a local reputation. There are no improvements.

ANALYSIS OF TYSON SPRING MINERAL WATER.

No. 690.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	1.0
Soda (Na_2O)-----	5.8
Lime (CaO)-----	23.7
Magnesia (MgO)-----	6.2
Ferric oxide (Fe_2O_3)-----	2.0
Sulphuric oxide (SO_3)-----	1.8
Chlorine (Cl)-----	3.6
Silica (SiO_2)-----	21.6
Total solids at $110^\circ C$.-----	128.0

HYPOTHETICAL FORM OF COMBINATION.

No. 690.

Name and Formula.	Parts per 1,000,000.
Sodium chloride (NaCl) -----	5.8
Sodium sulphate (Na ₂ SO ₄) -----	1.7
Potassium sulphate (K ₂ SO ₄) -----	1.8
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	2.6
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	8.5
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	4.4
Silica (SiO ₂) -----	1.6

GUERRENT SPRING, ROCKINGHAM COUNTY.

This spring is located about 4 miles northwest of Ruffin. It comes up through a sandy soil near a small branch. There are no exposures of rock in the vicinity. The water accumulates in a section of terra-cotta pipe and this is the only way the spring has been improved. The temperature of the water is 13.8° C. when the air temperature is 18° C., and the flow is about 1½ gallons per minute. The water is very clear and has no odor or taste of any kind. It is used quite extensively locally and the people around the spring have great faith in its curative properties.

ANALYSIS OF GUERRENT SPRING MINERAL WATER.

No. 729.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	.7
Soda (Na ₂ O) -----	9.3
Lime (CaO) -----	18.0
Magnesia (MgO) -----	6.9
Ferric oxide (Fe ₂ O ₃) -----	2.9
Sulphuric oxide (SO ₃) -----	4.5
Chlorine (Cl) -----	4.2
Silica (SiO ₂) -----	25.0
Total solids at 110° C. -----	104.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	6.8	.40
Sodium sulphate (Na ₂ SO ₄) -----	6.6	.38
Sodium bicarbonate (NaHCO ₃) -----	8.1	.48
Potassium sulphate (K ₂ SO ₄) -----	1.3	.07
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	25.0	1.46
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	trace	trace
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	51.8	3.02
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	6.4	0.37
Manganous bicarbonate (Mn(HCO ₃) ₂) -----	1.6	0.09
Silica (SiO ₂) -----	25.0	1.46
Total grains per gallon -----		7.73

There are no accommodations for guests and there is only one house near the spring. Close to the spring two log cabins have been built for the accommodation of guests.

HICK SPRING, RUTHERFORD COUNTY.

This spring is also known as the "Chalybeate Spring." It is in the town of Rutherfordton, on the bank of a small creek, and is subject to flooding when the creek rises. It has a very slow flow—only about one-fourth gallon per minute. The temperature of the water is 16.2°C . with an air temperature of 29°C . The water has a local reputation and is used locally. The only improvement that has been made is to sink a wooden box for the water to rise into. The water has no marked taste or odor and is very clear. It deposits a greenish sediment, which seems to be largely organic, on the sides of the wooden box.

ANALYSIS OF HICK OR CHALYBEATE SPRING MINERAL WATER.

No. 657.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	1.2
Soda (Na_2O)	4.8
Lime (CaO)	4.4
Magnesia (MgO)	2.5
Ferric oxide (Fe_2O_3)	3.1
Manganese oxide (Mn_2O_3)	1.4
Sulphuric oxide (SO_3)	1.1
Chlorine (Cl)	6.0
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	8.2
Total solids at 110°C .	131.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	.2	.59
Potassium sulphate (K_2O_4)	2.1	.12
Magnesium bicarbonate ($\text{Mg}(\text{HCO}_3)_2$)	5.6	2.66
Calcium phosphate (CaSO_4)	trace	trace
Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$)	9.5	4.05
Ferrous bicarbonate ($\text{Fe}(\text{HCO}_3)_2$)	8.8	1.70
Manganous bicarbonate ($\text{Mn}(\text{HCO}_3)_2$)	3.2	.18
Silica (SiO_2)	8.2	1.64
Total grains per gallon		10.94

HENSON SPRING, RUTHERFORD COUNTY.

This spring is known locally as the "Sulphur Spring" and is located about 10 miles south of Rutherfordton. It is situated on the slope of a hill about midway between top and bottom and flows out at the foot

of a large poplar. There is only a very faint odor and taste of sulphur, but it seems to contain a good deal of organic matter and has a milky appearance. The spring has a flow of only 1 gallon in 2 minutes and the temperature of the water is 15.6° C. when the air temperature is 24° C. The water has some little local use, but there are no provisions made for visitors.

ANALYSIS OF HENSON SPRING MINERAL
WATER.

No. 719.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	2.9
Soda (Na_2O)-----	8.7
Lime (CaO)-----	27.1
Magnesia (MgO)-----	3.2
Ferric oxide (Fe_2O_3)-----	2.5
Manganese oxide (Mn_2O_4)-----	2.8
Sulphuric oxide (SO_3)-----	7.5
Chlorine (Cl)-----	2.6
Hydrogen sulphide (H_2S)-----	trace
Silica (SiO_2)-----	37.2
Total solids at 110° C.-----	110.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	4.4	0.25
Sodium sulphate (Na_2SO_4)-----	9.4	0.55
Sodium bicarbonate ($NaHCO_3$)-----	6.1	0.35
Potassium sulphate (K_2SO_4)-----	5.5	0.30
Magnesium chloride ($MgCl_2$)-----	4.4	-----
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	11.7	0.68
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	78.7	4.58
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	5.5	0.32
Manganous bicarbonate ($Mn(HCO_3)_2$)-----	6.7	0.39
Hydrogen sulphide (H_2S)-----	trace	trace
Silica (SiO_2)-----	37.2	2.17
Total grains per gallon-----	-----	9.59

LEWIS SPRING, RUTHERFORD COUNTY.

This spring is near the house of Mr. Tolliver Lewis, 6 miles east of Rutherfordton, in a little gully close to the side of a creek. It is uncared for and had to be cleaned out in order to secure the sample. The water is milky in appearance, slightly sweetish to the taste and leaves a bitter after taste. The temperature of the water is 15.4° C. when that of the air is 26° C. The flow is very small—about 1 gallon in ten minutes. The water is little used and there are no accommodations for visitors nearer than Rutherfordton.

ANALYSIS OF LEWIS SPRING MINERAL WATER.

No. 720.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	.9
Soda (Na_2O) -----	1.9
Lime (CaO) -----	27.4
Magnesia (MgO) -----	2.3
Ferric oxide (Fe_2O_3) -----	5.9
Sulphuric oxide (SO_3) -----	.2
Chlorine (Cl) -----	4.0
Phosphoric oxide (P_2O_5) -----	.1
Silica (SiO_2) -----	35.8
Total solids at $110^{\circ} C.$ -----	70.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	3.6	0.21
Potassium sulphate (K_2SO_4) -----	.5	0.03
Potassium bicarbonate ($KHCO_3$) -----	1.3	0.08
Magnesium chloride ($MgCl_2$) -----	2.5	0.15
Magnesium sulphate ($MgSO_4$) -----	4.3	0.25
Calcium phosphate ($CaH_4(PO_4)_2$) -----	.3	0.02
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	78.8	5.02
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	13.1	0.76
Silica (SiO_2) -----	35.8	2.09
Total grains per gallon -----		8.61

MEISENHEIMER SPRING, CABARRUS COUNTY.

This spring is 8 miles west of New London, Stanly County. It is beside a creek and the water comes up through a sandy soil. There is a very distinct odor of hydrogen sulphide. The temperature is $17^{\circ} C.$ ($62.6^{\circ} F.$) and the flow is one-fourth gallon per minute.

ANALYSIS MEISENHEIMER SPRING MINERAL WATER.

No. 672.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	.3
Soda (Na_2O) -----	12.4
Lime (CaO) -----	41.9
Magnesia (MgO) -----	5.1
Ferric oxide (Fe_2O_3) -----	.9
Manganese oxide (Mn_2O_4) -----	3.8
Sulphuric oxide (SO_3) -----	6.5
Chlorine (Cl) -----	9.0
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	21.3
Total solids at $110^{\circ} C.$ -----	142.0

HYPOTHETICAL FORM OF COMBINATION.

No. 672.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)-----	14.8	0.86
Sodium sulphate (Na ₂ SO ₄)-----	11.0	0.64
Potassium sulphate (K ₂ SO ₄)-----	.5	0.03
Magnesium bicarbonate (Mg(HCO ₃) ₂)-----	18.6	1.08
Calcium phosphate (CaH ₄ (PO ₄) ₂)-----	trace	trace
Calcium bicarbonate (Ca(HCO ₃) ₂)-----	121.1	6.86
Ferrous bicarbonate (Fe(HCO ₃) ₂)-----	2.0	0.12
Manganous bicarbonate (Mn(HCO ₃) ₂)-----	8.9	0.52
Silica (SiO ₂)-----	21.3	1.24
Total grains per gallon-----		11.35

ROCKY RIVER SPRINGS, STANLY COUNTY.

These springs are situated at Rocky River Springs, in the southern part of Stanly County. They are five in number and are known as Arsenic Spring, Iron Spring, Sulphur Spring, Magnesia Spring and Blue Spring. The last one is not used. Samples for analysis were collected of only the first two. They are all included in a radius of 25 yards. They flow from a low bottom land lying between two small streams. All the springs have been dug out and a stone curbing built around them. A pavilion has been erected over each and there is a hotel near by for the accommodation of visitors.

The water from the Arsenic Spring is used largely at the hotel for drinking purposes. There is a whitish-yellow sediment deposited by the water which is collected and used for bathing purposes. The temperature of the water is about 16° C. (60.8° F.) and the flow is about three-fourths gallon per minute.

ANALYSES OF ROCKY RIVER SPRINGS MINERAL WATER.

Nos. 674, 673.

Name and Formula.	Arsenic Spring.	Iron Spring.
	Parts per 1,000,000.	Parts per 1,000,000.
Potash (K ₂ O)-----	.9	.6
Soda (Na ₂ O)-----	13.1	13.1
Lime (CaO)-----	41.0	40.6
Magnesia (MgO)-----	6.5	4.5
Ferric oxide (Fe ₂ O ₃)-----	2.9	2.8
Manganese oxide (Mn ₂ O ₃)-----	1.9	1.7
Sulphuric oxide (SO ₃)-----	15.2	13.0
Chlorine (Cl)-----	4.8	9.5
Phosphoric oxide (P ₂ O ₅)-----	trace	trace
Silica (SiO ₂)-----	38.9	36.4
Total solids at 110° C.-----	187.0	200.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Arsenic Spring.		Iron Spring.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	7.2	.46	15.6	.91
Sodium sulphate (Na ₂ SO ₄) -----	20.1	1.21	10.6	.62
Potassium sulphate (K ₂ SO ₄) -----	1.7	.09	1.1	.06
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	23.7	1.38	16.4	.96
Calcium sulphate (CaSO ₄) -----	9.2	.54	12.0	.70
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	trace	trace	trace	trace
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	106.9	6.23	101.1	5.90
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	6.5	.38	6.2	.36
Manganese bicarbonate (Mn(HCO ₃) ₂) -----	4.2	.25	3.9	.23
Silica (SiO ₂) -----	38.9	2.27	36.4	2.12
Total grains per gallon -----		12.81		11.86

The Iron Spring has a temperature of 16° C. and a flow of 2 gallons per minute.

The so-called "Sulphur Spring" has no odor of hydrogen sulphide.

MOORE SPRINGS, STOKES COUNTY.

This spring is located at Moore Springs, N. C., a few miles from Rural Hall, a station on the Southern Railway. The spring has been improved and developed and the water is being shipped quite extensively in barrels and in cases containing 12 half-gallon bottles. A hotel and several cottages furnish ample accommodations for guests. There are two of the springs, designated as spring No. 1 and spring No. 2, which are very similar in their chemical composition, as will be seen from the analyses below. Analyses of these springs have been made by Mr. F. A. Genth, Jr., of Philadelphia, who has reported the constituents in a hypothetical form of combination.

ANALYSES OF MOORE SPRINGS MINERAL WATER.

Name and Formula.	Grains per Gallon.	
	No. 1.	No. 2.
Sodium chloride (NaCl) -----	.44	.38
Sodium sulphate (Na ₂ SO ₄) -----	2.75	2.56
Potassium sulphate (K ₂ SO ₄) -----	1.78	1.20
Magnesium sulphate (MgSO ₄) -----	5.5	4.88
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	4.07	4.6
Calcium sulphate (CaSO ₄) -----	84.47	84.92
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	.30	.32
Aluminum oxide (Al ₂ O ₃) -----	trace	trace
Cupric oxide (CuO) -----	.08	.06
Lithia (Li ₂ O) -----	faint	faint
Hydrogen sulphide (H ₂ S) -----	trace	trace
Silica (SiO ₂) -----	1.30	1.65
Carbonic oxide (CO ₂) -----	undet.	undet.
Total grains per gallon at 100° C. -----	109.56	108.98

PIEDMONT IRON SPRING, STOKES COUNTY.

This and the following spring are $2\frac{1}{2}$ miles west of Danbury and 14 miles north of Walnut Cove on the Cape Fear and Yadkin Valley Railroad. They are both under the same spring house and issue from the same rock mass, though on different sides. One is chalybeate (iron) and the other is locally known as freestone. The springs are improved and the hotel for summer visitors is about 100 yards to the northeast. The chalybeate water is surrounded by moss and has a flow of about 1 gallon per minute. The temperature was 14.6° C.

The freestone spring has a flow of one-half gallon per minute and the temperature (July, 1896) was 15.8° C. The water is clear and without any odor.

ANALYSES OF PIEDMONT SPRINGS MINERAL WATER.

Nos. 651, 649.

Name and Formula.	Piedmont Iron Spring.	Piedmont Freestone Spring.
	Parts per 1,000,000.	Parts per 1,000,000.
Potash (K_2O)-----	3.7	1.5
Soda (Na_2O)-----	2.4	4.5
Lime (CaO)-----	11.0	5.9
Magnesia (MgO)-----	2.6	1.4
Ferric oxide (Fe_2O_3)-----	5.2	1.1
Manganese oxide (Mn_2O_3)-----	3.5	-----
Sulphuric oxide (SO_3)-----	3.2	.8
Chlorine (Cl)-----	3.4	4.4
Phosphoric oxide (P_2O_5)-----	trace	trace
Silica (SiO_2)-----	17.9	10.8
Total solids at 110° C.-----	82.6	51.6

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Piedmont Iron Spring.		Piedmont Freestone Spring.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	6.7	.39	7.7	.45
Potassium sulphate (K_2SO_4)-----	6.4	.37	2.6	.15
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	9.5	.55	5.1	.29
Calcium phosphate ($CaH_4(PO_4)_2$)-----	1.0	.05	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	32.3	1.88	17.1	.99
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	11.4	.66	2.3	.13
Manganous bicarbonate ($Mn(HCO_3)_2$)-----	8.2	.47	-----	-----
Silica (SiO_2)-----	17.9	1.04	10.8	.63
Total grains per gallon-----	-----	5.41	-----	2.64

WALNUT COVE SULPHUR SPRING, STOKES COUNTY.

This spring is 300 yards west of the junction of the Norfolk and Western and Cape Fear railroads at Walnut Cove. The spring is enclosed and the basin floored over, the water flowing from a pipe rising 3 feet 6 inches above the floor and curving so as to empty into a trough. The flow is less than 1 gallon per minute. There is no house in the immediate neighborhood. The water is used locally, but is not shipped. There is a slight odor of hydrogen sulphide. The temperature (July, 1896) was 15.4° C.

ANALYSIS OF WALNUT COVE SULPHUR SPRING
MINERAL WATER.

No. 653.

Name and Formula.	Parts per 1,000,000,
Potash (K ₂ O)-----	1.7
Soda (Na ₂ O)-----	31.0
Lime (CaO)-----	56.4
Magnesia (MgO)-----	9.9
Ferric oxide (Fe ₂ O ₃)-----	.8
Sulphuric oxide (SO ₃)-----	3.8
Chlorine (Cl)-----	14.2
Phosphoric oxide (P ₂ O ₅)-----	trace
Silica (SiO ₂)-----	26.8
Total solids at 110° C.-----	215.0

HYPOTHETICAL FORM OF COMBINATION.

No. 653.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)-----	24.1	1.40
Sodium sulphate (Na ₂ SO ₄)-----	14.4	.25
Sodium bicarbonate (NaHCO ₃)-----	28.9	1.68
Potassium sulphate (K ₂ SO ₄)-----	13.0	.17
Magnesium bicarbonate (Mg(HCO ₃) ₂)-----	36.2	2.11
Sulphureted hydrogen (H ₂ S)-----	undt.	undt.
Calcium phosphate (CaH ₄ (PO ₄) ₂)-----	trace	trace
Calcium bicarbonate (Ca(HCO ₃) ₂)-----	163.5	9.53
Ferrous bicarbonate (Fe(HCO ₃) ₂)-----	1.9	.11
Manganous bicarbonate (Mn(HCO ₃) ₂)-----	trace	trace
Silica (SiO ₂)-----	26.8	1.56
Total grains per gallon-----	-----	16.81

MOUNT AIRY WHITE SULPHUR SPRING, SURRY COUNTY.

This spring is within 50 feet of the Ararat River and is 3 miles northeast of Mount Airy. The spring is enclosed with stone and is carefully kept. The water is very clear, but deposits a whitish sediment and has a comparatively strong odor of hydrogen sulphide. The flow is about one-half gallon per minute and the temperature was at the time of taking the sample (July, 1896) 13.8° C.

ANALYSIS OF WHITE SULPHUR SPRING MINERAL WATER.

No. 650.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	4.8
Soda (Na ₂ O) -----	12.4
Lime (CaO) -----	21.2
Magnesia (MgO) -----	4.6
Ferric oxide (Fe ₂ O ₃) -----	4.8
Sulphuric oxide (SO ₃) -----	6.1
Chlorine (Cl) -----	4.6
Phosphoric oxide (P ₂ O ₅) -----	trace
Silica (SiO ₂) -----	20.7
Total solids at 110° C. -----	114.0

HYPOTHETICAL FORM OF COMBINATION.

No. 650.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	7.	.45
Sodium sulphate (Na ₂ SO ₄) -----	4.5	.26
Sodium bicarbonate (NaHCO ₃) -----	11.0	.64
Potassium sulphate (K ₂ SO ₄) -----	8.4	.49
Magnesium bicarbonate (Mg (HCO ₃) ₂) -----	16.8	.98
Sulphureted hydrogen (H ₂ S) -----	undt.	undt.
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	-----	trace
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	61.4	3.58
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	10.6	.61
Silica (SiO ₂) -----	20.7	1.20
Total grains per gallon -----	-----	8.21

VADE MECUM SPRING, STOKES COUNTY.

The Vade Mecum Spring is situated at Vade Mecum, near the center of Stokes County and 2½ miles southwest of Moore's Knob. It is about 16 miles from Rural Hall, a station at the junction of the Greensboro and Wilkesboro and the Cape Fear and Yadkin Valley railroads, two branches of the Southern Railway system, stages making the trip two or more times a day between the station and the hotel.

For many years this spring has had a local reputation, but it was not until about 1900 that it became generally known outside the county. The company have erected two hotels, constructed an artificial lake, and have made the place into a popular resort.*

The spring is situated just above the main water level of a small creek, and until the improvements were made, the spring was covered with sand and mud with every flood of the creek. It has been improved by high cement walls and a cement floor, which prevents any overflow from the creek. In the middle of the floor an 18-inch terra-cotta pipe

*Since this manuscript was begun a fire has destroyed the hotels, but it is very probable they will be rebuilt before another season.

sinks to the outlet of the spring, this outlet being a fissure in the country rock 12 inches long and 2 inches wide. The water stands 18 inches deep in the pipe up to the overflow pipe. A rough estimate of the flow of the spring was 7 gallons per minute. The water has no odor and no effervescent gases were observed. The temperature is 18° C. A bottling establishment of considerable importance is run in connection with the hotels and the water is shipped to a great many places.

ANALYSIS OF VADE MECUM MINERAL WATER.*

No. 029.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O)-----	8.40
Soda (Na ₂ O)-----	84.60
Lime (CaO)-----	656.80
Magnesia (MgO)-----	60.40
Ferric oxide (Fe ₂ O ₃)-----	1.70
Sulphuric oxide (SO ₃)-----	996.00
Chlorine (Cl)-----	9.00
Silica (SiO ₂)-----	13.20

*A. S. Wheeler, analyst.

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)-----	11.09	.85
Sodium sulphate (Na ₂ SO ₄)-----	177.40	10.29
Potassium sulphate (K ₂ SO ₄)-----	15.00	.87
Magnesium bicarbonate (Mg(HCO ₃) ₂)-----	219.80	12.75
Calcium bicarbonate (Ca(HCO ₃) ₂)-----	97.75	5.67
Calcium sulphate (CaSO ₄)-----	1,512.00	87.72
Silica (SiO ₂)-----	13.20	.76

FUQUAY SPRING, WAKE COUNTY.

This spring is located about 13 miles southeast of Apex, Wake County, and about 4 miles from Verina. The property is owned by a joint-stock company. The spring is in a little hollow on the bank of a small branch and there are no houses at the spring, though there were some years ago, when the spring had a considerable reputation. Quite lately a small framed boarding-house has been built about 200 yards from the spring, but the accommodations for guests are very poor. The spring itself is small and flows up into a wooden box at about the rate of one-half gallon per minute. The temperature is 16.4° C. The water has no odor or taste when drunk, but leaves a bitter after taste in the mouth and generally colors a tin dipper yellow.

ANALYSIS OF FUQUAY SPRING MINERAL WATER.
No. 727.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	1.0
Soda (Na_2O) -----	11.0
Lime (CaO) -----	27.9
Magnesia (MgO) -----	3.9
Ferric oxide (Fe_2O_3) -----	4.4
Manganese oxide (Mn_2O_4) -----	2.4
Sulphuric oxide (SO_3) -----	5.8
Chlorine (Cl) -----	4.0
Phosphoric oxide (P_2O_5) -----	.1
Silica (SiO_2) -----	52.0
Total solids at $110^{\circ} C$. -----	157.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$) -----	6.5	.38
Sodium sulphate (Na_2SO_4) -----	7.5	.44
Sodium bicarbonate ($NaHCO_3$) -----	10.8	.59
Potassium sulphate (K_2SO_4) -----	1.9	.11
Magnesium bicarbonate ($Mg(HCO_3)_2$) -----	14.1	.61
Calcium bicarbonate ($Ca(HCO_3)_2$) -----	80.3	4.68
Ferrous bicarbonate ($Fe(HCO_3)_2$) -----	9.8	.57
Manganous bicarbonate ($Mn(HCO_3)_2$) -----	5.6	.33
Calcium phosphate ($CaH_4(PO_4)_2$) -----	.2	.02
Silica (SiO_2) -----	52.0	3.03
Total grains per gallon -----		10.76

MACON SPRING, WARREN COUNTY.

This spring is located about 1 mile from Warrenton, close to the bank of a small stream. The water comes up into a section of terra-cotta pipe about 4 feet deep. The water is very clear, has no odor, but has a slightly bitter taste. The flow is about 2 gallons per minute.

ANALYSIS OF MACON SPRING MINERAL WATER.
No. 716.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O) -----	2.0
Soda (Na_2O) -----	8.0
Lime (CaO) -----	6.9
Magnesia (MgO) -----	2.3
Ferric oxide (Fe_2O_3) -----	.2
Sulphuric oxide (SO_3) -----	.5
Chlorine (Cl) -----	4.8
Phosphoric oxide (P_2O_5) -----	trace
Silica (SiO_2) -----	32.7
Total solids at $110^{\circ} C$. -----	70.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	7.8	.46
Sodium bicarbonate (NaHCO ₃) -----	15.4	.90
Potassium sulphate (K ₂ SO ₄) -----	1.2	.07
Potassium bicarbonate (KHCO ₃) -----	2.7	.16
Potassium phosphate (KH ₂ PO ₄) -----	trace	trace
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	8.3	.48
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	19.8	1.15
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	.3	.02
Silica (SiO ₂) -----	32.7	1.90
Total grains per gallon -----		5.14

The temperature of the water at the time of the visit was 13.6° C. and of the air, 28.8° C. The water has a considerable local reputation.

DESCRIPTION OF SPRINGS IN MOUNTAIN REGION.

DAVIS WHITE SULPHUR SPRING, ALEXANDER COUNTY.

This spring, formerly known as Alexandria, is 1½ miles north of Hiddenite, a station on the Taylorsville branch of the Southern Railroad. The water flows about 1 gallon in 3 minutes. It has a very perceptible odor and taste of hydrogen sulphide and bubbles of gas can be seen escaping from the water. It is situated at the base of a hill near the bank of Davis Creek at an altitude of 1,100 feet. The temperature, taken in the summer of 1897, was 17.4° C. (63.3° F.). This spring has been known for over a hundred years and has been used locally for a great many years. In the spring of 1905, Messrs. William J. and Robert L. Davis erected a small hotel for the accommodation of visitors, which was enlarged in 1906 and again 1907, and they now have 87 rooms (Pl. XIII). The buildings are neatly furnished and have all modern improvements, such as electric lights, hot and cold baths, sewerage system, etc. The buildings are delightfully located on a knoll in a grove of oak trees. The surrounding hills and mountains offer attractive walks. There is a resident physician in attendance at the hotel. Analyses show the spring to be a sulphur water of exceptional purity.

ANALYSIS OF DAVIS WHITE SULPHUR SPRING MINERAL
No. 679. WATER.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	65.0
Soda (Na_2O)	4.3
Lime (CaO)	3.3
Magnesia (MgO)	2.3
Ferric oxide (Fe_2O_3)	1.3
Sulphuric oxide (SO_3)	5.0
Chlorine (Cl)	3.8
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	20.0
Sulphureted hydrogen (H_2S)	undet.
Total solids at $110^\circ C$	158.0

HYPOTHETICAL FORM OF COMBINATION.

No. 677.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	6.3	.37
Sodium sulphate (Na_2SO_4)	2.5	.15
Sodium bicarbonate ($NaHCO_3$)	160.4	9.35
Potassium sulphate (K_2SO_4)	7.9	.46
Magnesium bicarbonate ($Mg(HCO_3)_2$)	8.4	.49
Calcium phosphate ($CaH_4(PO_4)_2$)	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	9.5	.55
Ferrous bicarbonate ($Fe(HCO_3)_2$)	2.9	.17
Silica (SiO_2)	20.0	1.17
Total grains per gallon		12.71

ALL HEALING SPRINGS, ALEXANDER COUNTY.

This spring is 6 miles from Taylorsville. It is in a bottom near a small branch and cased in a wood box. There is a small hotel near for the accommodation of visitors. The water has no odor or taste. It is used internally and for bathing. The flow is about 2 gallons per minute and the temperature (taken in the summer of 1897) was $14.8^\circ C$. ($58.6^\circ F$).

ANALYSIS OF ALL HEALING SPRINGS MINERAL WATERS.

No. 679.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	2.6
Soda (Na_2O)	8.9
Lime (CaO)	22.9
Magnesia (MgO)	3.0
Ferric oxide (Fe_2O_3)	1.0
Sulphuric oxide (SO_3)	7.0
Chlorine (Cl)	4.0
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	25.2
Total solids at $110^\circ C$	128.0

HYPOTHETICAL FORM OF COMBINATION.

No. 679.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	6.5	.38
Sodium sulphate (Na_2SO_4)	8.5	.50
Sodium bicarbonate (NaHCO_3)	4.6	.27
Potassium sulphate (K_2SO_4)	4.8	.28
Magnesium bicarbonate ($\text{Mg}(\text{HCO}_3)_2$)	10.9	.64
Calcium phosphate ($\text{CaH}_4(\text{PO}_4)_2$)	trace	trace
Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$)	66.2	3.86
Ferrous bicarbonate ($\text{Fe}(\text{HCO}_3)_2$)	2.2	.13
Silica (SiO_2)	25.2	1.46
Total grain per gallon		7.52

WATTS CHALYBEATE SPRING, ALEXANDER COUNTY.

This spring is 10 miles west of Taylorsville. The water issues from near the bottom of a hill and is caught in a heavy wooden box. It flows at the rate of about 1 gallon per minute, and makes a deposit of iron oxide. The temperature of the water in the summer of 1897 was 14.4°C . (58°F .).

ANALYSIS OF WATTS CHALYBEATE SPRING MINERAL WATER.

No. 680.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	2.5
Soda (Na_2O)	7.6
Lime (CaO)	9.8
Magnesia (MgO)	3.3
Ferric oxide (Fe_2O_3)	4.0
Manganese oxide (Mn_2O_3)	.5
Sulphuric oxide (SO_3)	8.4
Chlorine (Cl)	3.6
Phosphoric oxide (P_2O_5)	trace
Silica (SiO_2)	26.8
Total solids at 110°C	88.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	5.9	.34
Sodium sulphate (Na_2SO_4)	11.2	.65
Potassium sulphate (K_2SO_4)	4.6	.27
Magnesium bicarbonate ($\text{Mg}(\text{HCO}_3)_2$)	12.0	.70
Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$)	28.3	1.65
Ferrous bicarbonate ($\text{Fe}(\text{HCO}_3)_2$)	3.8	.55
Manganous bicarbonate ($\text{Mn}(\text{HCO}_3)_2$)	1.1	.06
Silica (SiO_2)	26.8	1.56
Total grains per gallon		5.78

LOWDERMILK SPRING, ALEXANDER COUNTY.

This spring is located 3 miles west of Taylorsville and near the bank of Lower Little River. Some years ago this spring had quite a reputation and was largely used by visitors. There are a number of cabins near the spring and these were always occupied in the summer. The spring is now uncared for, and had to be cleaned out before a sample could be taken.

ANALYSIS OF LOWDERMILK SPRING MINERAL WATER.

No. 325.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	1.4
Soda (Na_2O)-----	71.5
Lime (CaO)-----	2.0
Magnesia (MgO)-----	5.8
Ferric oxide (Fe_2O_3)-----	12.0
Sulphuric oxide (SO_3)-----	4.3
Chlorine (Cl)-----	23.2
Hydrogen sulphide (H_2S)-----	.2
Phosphoric oxide (P_2O_5)-----	trace
Silica (SiO_2)-----	31.3
Total solids at $110^{\circ} C$.-----	214.6

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	37.5	2.19
Sodium sulphate (Na_2SO_4)-----	5.5	.32
Sodium bicarbonate ($NaHCO_3$)-----	135.5	6.06
Sodium sulphide (Na_2S)-----	.5	.02
Potassium sulphate (K_2SO_4)-----	2.6	.15
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	21.0	1.22
Calcium phosphate ($CaH_4(PO_4)_2$)-----	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	5.7	.33
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	26.7	1.55
Hydrogen sulphide (H_2S)-----	.2	-----
Silica (SiO_2)-----	31.3	1.83
Total grains per gallon-----	-----	13.66

The water was milky and had a very decided odor and taste of hydrogen sulphide. The temperature of the water was $15.2^{\circ} C$. with an air temperature of $33.2^{\circ} C$. The flow was about 1 gallon in 4 minutes. The spring had no wooden or stone casing around it.

ASHEVILLE CHALYBEATE SPRING, BUNCOMBE COUNTY.

This is also known as Armstrong's Spring and is about 2 miles east of Asheville. The water has been sold in Asheville.

ANALYSIS OF ASHEVILLE CHALYBEATE SPRING
MINERAL WATER.

No. 626.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O)-----	3.7
Soda (Na ₂ O)-----	9.2
Lime (CaO)-----	7.5
Magnesia (MgO)-----	7.2
Ferric oxide (Fe ₂ O ₃)-----	3.5
Sulphuric oxide (SO ₃)-----	8.0
Chlorine (Cl)-----	8.0
Silica (SiO ₂)-----	38.8
Total solids at 110° C.-----	145.6

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)-----	13.5	.79
Sodium sulphate (Na ₂ SO ₄)-----	3.0	.17
Potassium sulphate (K ₂ SO ₄)-----	6.9	.40
Magnesium bicarbonate (Mg(HCO ₃) ₂)-----	26.3	1.54
Calcium sulphate (CaSO ₄)-----	5.3	.31
Calcium bicarbonate (Ca(HCO ₃) ₂)-----	73.2	4.27
Ferrous bicarbonate (Fe(HCO ₃) ₂)-----	73.2	.45
Silica (SiO ₂)-----	38.8	2.26
Total grains per gallon-----		10.19

GLEN MONT SPRING, BUNCOMBE COUNTY.

This spring, known at one time as Coggin's, is situated 7 miles north-east of Asheville and about 4½ miles from the Western North Carolina Railroad. The flow is about one-half gallon per minute and the temperature in July, 1895, was 14.4° C. (58° F.). There are no improvements, and the spring water is only used to a limited extent locally.

ANALYSIS OF GLEN MONT SPRING MINERAL
WATER.

No. 627.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O)-----	7.9
Soda (Na ₂ O)-----	4.6
Lime (CaO)-----	18.1
Magnesia (MgO)-----	6.7
Ferric oxide (Fe ₂ O ₃)-----	3.5
Sulphuric oxide (SO ₃)-----	6.8
Chlorine (Cl)-----	8.6
Silica (SiO ₂)-----	34.2
Total solids at 110° C.-----	130.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	7.6	.44
Potassium sulphate (K ₂ SO ₄) -----	4.7	.86
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	24.4	1.42
Calcium chloride (CaCl ₂) -----	5.3	.31
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	46.0	2.68
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	7.7	.45
Silica (SiO ₂) -----	34.2	1.99
Total grains per gallon -----		8.15

SUTTON SPRING, BUNCOMBE COUNTY.

This spring is 2 miles east of Asheville, at the foot of Beaumont Mountain, and has a flow of about 1½ gallons per minute. The temperature of the water was 14.8° C. (July, 1895).

ANALYSIS OF SUTTON SPRING MINERAL WATER.

No. 629.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	3.3
Soda (Na ₂ O) -----	8.2
Lime (CaO) -----	17.5
Magnesia (MgO) -----	5.8
Ferric oxide (Fe ₂ O ₃) -----	5.2
Sulphuric oxide (SO ₃) -----	7.1
Chlorine (Cl) -----	8.0
Silica (SiO ₂) -----	37.3
Total solids at 110° C. -----	123.5

HYPOTHETICAL FORM OF COMBINATION.

No. 629.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	12.9	.75
Sodium sulphate (Na ₂ SO ₄) -----	7.6	.44
Potassium sulphate (K ₂ SO ₄) -----	6.1	.35
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	21.1	1.23
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	50.6	2.95
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	11.3	.66
Silica (SiO ₂) -----	37.3	2.17
Total grains per gallon -----		8.55

ASHEVILLE WHITE SULPHUR SPRING, BUNCOMBE COUNTY.

This spring, also known as Carrier's, is situated 5 miles west of Asheville and is connected with the city by a trolley line. A large hotel was erected near by, but was lost by fire. This is now (1908) being rebuilt, and it is expected that this place will again become a

very popular resort. The spring is neatly enclosed and covered. It has a good flow and the temperature ranges from 15 to 16° C. (about 60° F.). There is a strong odor of hydrogen sulphide and bubbles of escaping gas can readily be detected.

ANALYSIS OF ASHEVILLE WHITE SULPHUR SPRING
MINERAL WATER.

No. 630.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	1.6
Soda (Na ₂ O) -----	10.5
Lime (CaO) -----	27.2
Magnesia (MgO) -----	7.8
Ferric oxide (Fe ₂ O ₃) -----	1.4
Sulphuric oxide (SO ₃) -----	2.4
Chlorine (Cl) -----	11.0
Phosphoric oxide (P ₂ O ₅) -----	trace
Hydrogen sulphide (H ₂ S) -----	undet.
Silica (SiO ₂) -----	32.3

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	20.5	1.20
Sodium sulphate (Na ₂ SO ₄) -----	2.0	.12
Potassium sulphate (K ₂ SO ₄) -----	2.9	.17
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	35.6	2.08
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	trace	
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	78.7	4.59
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	3.1	.18
Hydrogen sulphide (H ₂ S) -----	undet.	
Silica (SiO ₂) -----	32.3	1.88
Total grains per gallon -----		10.22

BLACKWELL SULPHUR SPRING, BUNCOMBE COUNTY.

This spring is located in Buncombe County about 4 miles west of Alexander, a station on the Southern Railroad. It is close to the banks of a bold stream, but is sufficiently high above the stream not to be flooded by its overflow. There are ample accommodations for guests, and the spring has been carefully enclosed and protected. The water is very clear and leaves but very little deposit. It has a distinct odor of hydrogen sulphide. The flow of the spring is about three-fourths of a gallon per minute and the temperature 14.6° C.

ANALYSIS OF BLACKWELL SULPHUR SPRING
No. 634. MINERAL WATER.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	3.8
Soda (Na_2O)	13.1
Lime (CaO)	30.0
Magnesium (MgO)	9.2
Ferric oxide (Fe_2O_3)	1.3
Sulphuric oxide (SO_3)	6.5
Chlorine (Cl)	1.2
Phosphoric oxide (P_2O_5)	undet.
Hydrogen sulphide (H_2S)	undet.
Silica (SiO_2)	30.9
Total solids at $110^{\circ} C.$	120.0

HYPOTHETICAL FORM OF COMBINATION.

	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	22.5	1.31
Sodium bicarbonate ($NaHCO_3$)	5.8	.34
Potassium sulphate (K_2SO_4)	7.0	.41
Magnesium bicarbonate ($Mg(HCO_3)_2$)	33.6	1.96
Calcium phosphate ($CaH_4(PO_4)_2$)		trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	86.6	5.06
Ferrous bicarbonate ($Fe(HCO_3)_2$)	30.0	.17
Hydrogen sulphide (H_2S)	undet.	
Silica (SiO_2)	30.9	1.80
Total grains per gallon		11.05

CONNELLY SPRING, BURKE COUNTY.

This well-known spring is on the line of the Southern Railroad and is the property of the Connelly Springs Company. It is well improved and there are large buildings for the entertainment of guests. The spring is enclosed in a marble basin. The water is clear and flows at the rate of about one-half gallon per minute. There is no odor, but a metallic taste. The outflowing water gives an abundant deposit of ferric hydroxide. The temperature was $16.8^{\circ} C.$ (July, 1895). Commercial shipments of the water have occasionally been made.

ANALYSIS OF CONNELLY SPRING MINERAL
No. 628. WATER.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	1.1
Soda (Na_2O)	1.2
Lime (CaO)	9.0
Magnesia (MgO)	1.0
Ferric oxide (Fe_2O_3)	7.2
Sulphuric oxide (SO_3)	.5
Chlorine (Cl)	2.0
Silica (SiO_2)	4.8
Total solids at $110^{\circ} C.$	42.5

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	2.7	.16
Potassium chloride (KCl) -----	1.1	.06
Potassium sulphate (K ₂ SO ₄) -----	1.1	.06
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	2.6	.21
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	26.0	1.52
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	16.0	.93
Silica (SiO ₂) -----	4.8	.28
Total grains per gallon -----		3.22

PIEDMONT SPRINGS, BURKE COUNTY.

These springs are about 16 $\frac{1}{2}$ miles north of Morganton, on the bank of Upper Creek. There are two springs, a sulphur spring and an iron spring. The latter is very little used and has been allowed to fill up, so no sample of this was taken. The sulphur spring has a flow of about one-quarter gallon per minute. The temperature of the water was 16.4° C. The odor of hydrogen sulphide is very faint, but the taste is very pronounced. The spring, which is built up with rock, is not very well cared for and is allowed to fill in with leaves. There was a small hotel that was formerly used to accommodate guests, but this has been given up.

ANALYSIS OF PIEDMONT SULPHUR SPRING MINERAL

No. 722.

WATER.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	9.7
Soda (Na ₂ O) -----	121.4
Lime (CaO) -----	1.7
Magnesia (MgO) -----	1.1
Ferric oxide (Fe ₂ O ₃) -----	2.3
Sulphuric oxide (SO ₃) -----	2.1
Chlorine (Cl) -----	78.0
Phosphoric oxide (P ₂ O ₅) -----	.1
Sulphureted hydrogen (H ₂ S) -----	undet.
Silica (SiO ₂) -----	17.7
Total solids at 110° C. -----	316.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	126.4	7.37
Sodium bicarbonate (NaHCO ₃) -----	143.6	8.37
Potassium sulphate (K ₂ SO ₄) -----	4.6	.27
Potassium bicarbonate (KHCO ₃) -----	15.2	.89
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	.3	.02
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	4.9	.29
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	4.9	.23
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	5.1	.30
Sulphureted hydrogen (H ₂ S) -----	undet.	undet.
Silica (SiO ₂) -----	17.7	1.03
Total grains per gallon -----		18.77

GLEN ALPINE SPRING, BURKE COUNTY.

This spring is situated 14 miles southwest of Morganton. It is protected by a stone basin. It is used for table water by the Glen Alpine Springs School. A large flocculent precipitate is formed by the water inflowing from one basin to another and escaping by exit trough. The flow is slight, about 1 gallon in 5 minutes. The temperature (late summer of 1897) was 15.4° C. (56.6° F.).

ANALYSIS OF GLEN ALPINE SPRING MINERAL WATER.

No. 676.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	3.8
Soda (Na ₂ O) -----	10.4
Lime (CaO) -----	27.0
Magnesia (MgO) -----	5.2
Ferric oxide (Fe ₂ O ₃) -----	3.5
Manganese oxide (Mn ₂ O ₄) -----	.4
Sulphuric oxide (SO ₃) -----	10.5
Chlorine (Cl) -----	3.6
Phosphoric oxide (P ₂ O ₅) -----	trace
Silica (SiO ₂) -----	26.6
Total solids at 110° C. -----	120.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	5.9	.34
Sodium sulphate (Na ₂ SO ₄) -----	14.5	.85
Potassium sulphate (K ₂ SO ₄) -----	7.0	.41
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	18.9	1.10
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	trace	.45
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	78.0	trace
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	7.7	.45
Manganous bicarbonate (Mn(HCO ₃) ₂) -----	7.9	.05
Silica (SiO ₂) -----	26.6	1.55
Total grains per gallon -----		5.20

LIMESTONE SPRING, CHEROKEE COUNTY.

This spring is 4 miles northeast of Murphy and about 100 feet east of the Valley River road connecting Murphy with Andrews. It is several hundred feet southwest of and well above Marble Creek. The water issues out of a mass of marble and flows at the rate of 3 gallons per minute. The temperature of the spring was 14° C.

ANALYSIS OF LIMESTONE SPRING MINERAL WATER.

No. 639.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O)	1.8
Soda (Na ₂ O)	2.6
Lime (CaO)	46.1
Magnesia (MgO)	6.5
Ferric oxide (Fe ₂ O ₃)	3.0
Sulphuric oxide (SO ₃)	2.0
Chlorine (Cl)	6.2
Silica (SiO ₂)	13.0
Total solids at 110° C.	165.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	2.7	.16
Potassium sulphate (K ₂ SO ₄)	3.3	.19
Magnesium bicarbonate (Mg(HCO ₃) ₂)	24.6	1.43
Calcium chloride (CaCl ₂)	7.0	.41
Calcium bicarbonate (Ca(HCO ₃) ₂)	122.6	7.15
Ferrous bicarbonate (Fe(HCO ₃) ₂)	6.7	.39
Silica (SiO ₂)	13.0	.75
Total grains per gallon		10.48

PATTERSON SPRING, CHEROKEE COUNTY.

This spring is 3 miles southeast of Murphy. The water issues from a sedimentary rock and flows at the rate of 1 gallon per minute, forming a deposit of iron hydroxide. The temperature of the water was 15° C.

ANALYSIS OF PATTERSON SPRING MINERAL WATER.

No. 642.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O)	4.4
Soda (Na ₂ O)	18.3
Lime (CaO)	26.3
Magnesia (MgO)	6.4
Ferric oxide (Fe ₂ O ₃)	8.1
Sulphuric oxide (SO ₃)	10.9
Chlorine (Cl)	6.0
Phosphoric oxide (P ₂ O ₅)	trace
Silica (SiO ₂)	24.9
Total solids at 110° C.	144.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	10.2	.59
Sodium sulphate (Na ₂ SO ₄) -----	13.5	.79
Sodium bicarbonate (NaHCO ₃) -----	12.3	.72
Potassium sulphate (K ₂ SO ₄) -----	7.7	.45
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	24.2	1.41
Calcium phosphate (CaH ₄ (PO ₄) ₂) -----	trace	trace
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	76.3	4.45
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	17.8	1.04
Silica (SiO ₂) -----	24.9	1.45
Total grains per gallon -----		10.90

TORPLEY YOUNG SPRING, CHEROKEE COUNTY.

This spring is situated about 1 mile east of Valleytown. It had a flow of 2 gallons per minute and a temperature of 14° C.

ANALYSIS OF TORPLEY YOUNG SPRING MINERAL WATER.

No. 643.

Name and Formula.	Parts per 1,000,000.
Potash (K ₂ O) -----	6.2
Soda (Na ₂ O) -----	7.0
Lime (CaO) -----	27.5
Magnesia (MgO) -----	5.6
Ferric oxide (Fe ₂ O ₃) -----	7.3
Sulphuric oxide (SO ₃) -----	10.3
Chlorine (Cl) -----	7.5
Silica (SiO ₂) -----	19.6
Total solids at 110° C. -----	125.0

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl) -----	12.9	.75
Sodium sulphate (Na ₂ SO ₄) -----	1.2	.07
Potassium sulphate (K ₂ SO ₄) -----	11.1	.65
Magnesium bicarbonate (Mg(HCO ₃) ₂) -----	20.4	1.19
Calcium sulphate (CaSO ₄) -----	8.3	.48
Calcium bicarbonate (Ca(HCO ₃) ₂) -----	69.8	4.07
Ferrous bicarbonate (Fe(HCO ₃) ₂) -----	16.1	.94
Silica (SiO ₂) -----	16.6	1.14
Total grains per gallon -----		5.29

HAYWOOD WHITE SULPHUR SPRING, HAYWOOD COUNTY.

This spring is located about 1 mile west from Waynesville. This property is another of those containing mineral springs of considerable note that have been built up more for resort purposes than for health, the mineral spring water, however, being one of the attractions of the

place. The hotel and annex contain about 90 rooms and is equipped with all modern conveniences, as hot and cold water, electric lights, etc. The grounds around the hotel comprise 50 acres and are picturesque and attractive, the wooded mountains rising to the rear of the hotel, and the Richland River flowing at the foot of the lawn in front of the hotel. The spring is enclosed in a stone basin and covered by an attractive pavilion. The flow of water is apparently several gallons per minute, but it could not be measured accurately. The temperature in July was 14° C. The spring has a distinct odor and taste of hydrogen sulphide.

ANALYSIS OF HAYWOOD WHITE SULPHUR SPRING
MINERAL WATER.

No. 646.

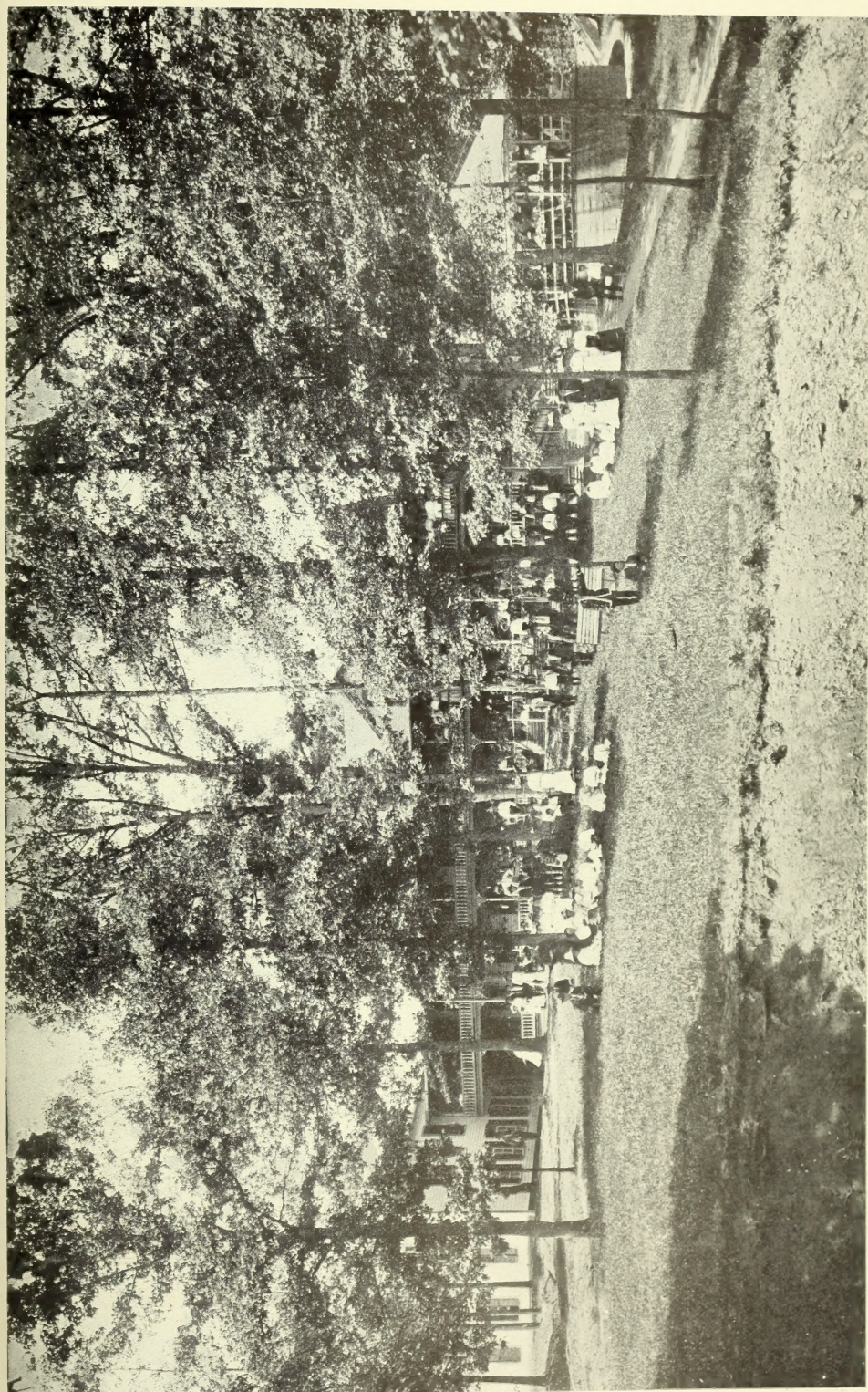
Name and Formula.	Parts per 1,000,000.
Potash (K_2O)	2.1
Soda (Na_2O)	9.7
Lime (CaO)	17.6
Magnesia (MgO)	2.6
Ferric oxide (Fe_2O_3)	.5
Sulphuric oxide (SO_3)	.7
Chlorine (Cl)	5.6
Phosphoric oxide (P_2O_5)	trace
Hydrogen sulphide (H_2S)	undet.
Silica (SiO_2)	23.5
Total solids at 110° C.	100.0

HYPOTHETICAL FORM OF COMBINATION.

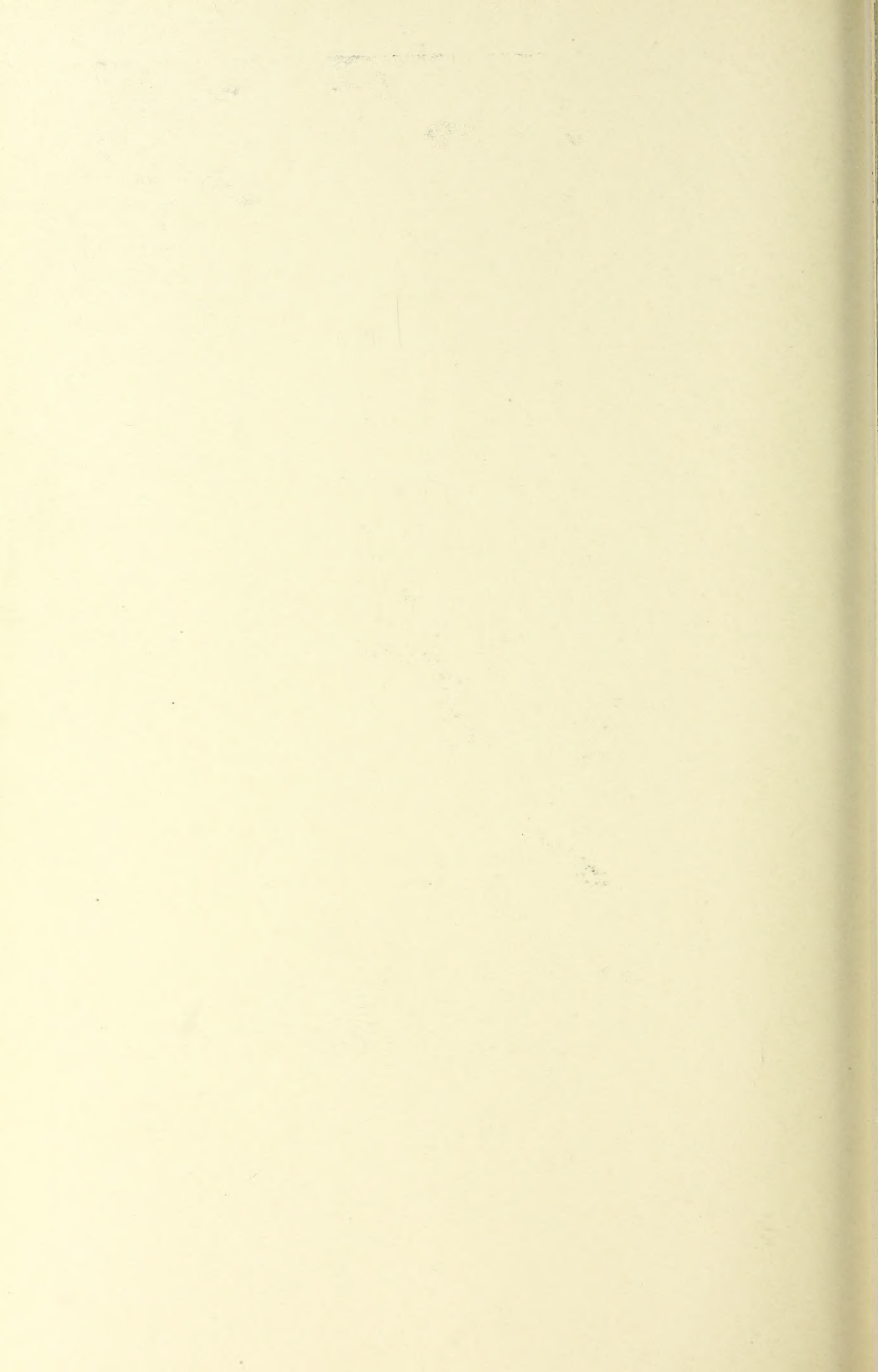
Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)	9.5	.55
Sodium sulphate (Na_2SO_4)	9.8	.57
Potassium sulphate (K_2SO_4)	3.6	.21
Magnesium bicarbonate ($Mg(HCO_3)_2$)	9.5	.55
Calcium phosphate ($CaH_4(PO_3)_2$)	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)	4.93	2.87
Lithium bicarbonate ($Li(HCO_3)_2$)	trace	trace
Ferrous bicarbonate ($Fe(HCO_3)_2$)	1.1	.06
Hydrogen sulphide (H_2S)	undet.	undet.
Silica (SiO_2)	23.5	1.37
Total grains per gallon		6.18

HAYWOOD CHALYBEATE SPRING, HAYWOOD COUNTY.

This spring, which is a strongly chalybeate one, is situated to the rear of the White Sulphur Spring Hotel and about 1 mile distant from the sulphur spring. The flow is from 1 to 2 gallons per minute and the temperature in the summer was very little below that of the air. There was a considerable deposit of iron hydroxide in the outflow. The spring was roughly walled in and kept clean, and is only used occasionally.



DAVIS SPRING HOTEL AND SPRING-HOUSE, HIDDENITE, N. C.



ANALYSIS OF HAYWOOD CHALYBEATE SPRING
MINERAL WATER.

No. 645.

Name and Formula.	Parts per 1,000,000.
Potash (K_2O)-----	3.0
Soda (Na_2O)-----	5.3
Lime (CaO)-----	18.0
Magnesia (MgO)-----	6.1
Ferric oxide (Fe_2O_3)-----	330.6
Sulphuric oxide (SO_2)-----	2.0
Chlorine (Cl)-----	7.6
Phosphoric oxide (P_2O_5)-----	trace
Silica (SiO_2)-----	34.8

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride ($NaCl$)-----	10.8	.63
Potassium sulphate (K_2SO_4)-----	5.3	.30
Magnesium bicarbonate ($Mg(HCO_3)_2$)-----	22.3	1.30
Calcium chloride ($CaCl_2$)-----	1.4	.08
Calcium phosphate ($CaH_4(PO_4)_2$)-----	trace	trace
Calcium bicarbonate ($Ca(HCO_3)_2$)-----	50.5	2.94
Ferrous bicarbonate ($Fe(HCO_3)_2$)-----	727.3	42.40
Silica (SiO_2)-----	134.8	7.86
Total grains per gallon-----		55.51

EPPS SPRING, SWAIN COUNTY.

This spring is located at the foot of East Canebrake Knob, about 5 miles west of Bryson City and 150 yards up Canebrake Branch from Epps Spring, a station on the Murphy branch of the Southern Railway. There is a small hotel, containing 12 rooms, that has been built for the accommodation of guests, which is within 50 yards of this spring, and has running water. There are 500 acres of ground belonging to the spring property, which is largely covered with timber, as oak, poplar, chestnut and some pine. Although there have been but little improvements made on this property, it offers a favorable location for building up a mineral spring resort, as the spring has exceptional medicinal properties, as is seen from the analysis given below. Canebrake Branch offers sufficient power to develop electricity for lighting the hotel.

The water from Epps Spring gushes out from the rock on the west side of a steep hill and is within about 30 feet of Canebrake Branch, but well above it. The flow of the spring is 1 gallon in 3 minutes. The temperature of the water was 60° F. in the summer of 1908.

About 60 yards from the Epps Spring and on the opposite side of

Canebrake Branch there is another spring, known as the Dairy Spring, which has also been analyzed, and, on account of the great contrast between the two, this analysis is also given.

The analysis of the Epps Spring showed an unusually large amount of solid matter, about one-fourth of this being magnesium sulphate, epsom salts, which gives the spring very high medicinal properties. On the other hand, the Dairy Spring showed a small content of mineral matter, but is a very pure water. The analyses of these waters were made by Mr. A. S. Wheeler, of the University of North Carolina, who reported the results in a hypothetical form of combination, as follows:

ANALYSES OF EPPS SPRING AND DAIRY SPRING MINERAL WATERS.

Name and Formula.	Parts per 1,000,000.	
	Epps Spring.	Dairy Spring.
Sodium chloride (NaCl)	10.9	6.59
Sodium sulphate (Na ₂ SO ₄)	38.1	3.79
Potassium sulphate (K ₂ SO ₄)	13.8	2.78
Magnesium sulphate (MgSO ₄)	303.1	
Calcium sulphate (CaSO ₄)	884.0	16.24
Magnesium bicarbonate (Mg(HCO ₃) ₂)	23.9	4.02
Calcium bicarbonate (Ca(HCO ₃) ₂)	61.6	10.35
Iron oxide (Fe ₂ O ₃) {	20.0	1.97
Alumina (Al ₂ O ₃) {		
Free carbon dioxide gas (CO ₂)	noted	none
Silica (SiO ₂)	12.0	15.7
Total solids at 110° C.	1367.4	61.44

HYPOTHETICAL FORM OF COMBINATION.

Name and Formula.	Epps Spring.		Dairy Spring.	
	Parts per 1,000,000.	Grains per Gallon.	Parts per 1,000,000.	Grains per Gallon.
Sodium chloride (NaCl)	10.9	.63	6.59	.38
Sodium sulphate (Na ₂ SO ₄)	38.1	2.21	3.79	.21
Potassium sulphate (K ₂ SO ₄)	13.8	.80	2.78	.16
Magnesium sulphate (MgSO ₄)	303.1	17.57		
Magnesium bicarbonate (Mg(HCO ₃) ₂)	23.9	1.38	4.02	.23
Calcium sulphate (CaSO ₄)	884.0	51.28	16.24	.94
Calcium bicarbonate (Ca(HCO ₃) ₂)	61.6	3.57	10.35	.60
Ferric and aluminum oxide (Fe ₂ O ₃ , Al ₂ O ₃)	20.0	1.16	1.97	.11
Silica (SiO ₂)	12.0	.69		
Total grains per gallon		79.29		.63

PRODUCTION.

During the year 1907 there were 13 springs that reported a production of mineral water that was put on the market. The production amounted to 193,499 gallons valued at \$40,302, as compared with 158,680 gallons valued at \$31,413, the production of 1906. The aver-

age price per gallon received for the 1907 production was 21 cents, the price varying from 10 to 30 cents per gallon. Of this production a portion was shipped simply for table water and its value amounted to \$3,040; the balance of the production, valued at \$37,262, was shipped on account of the medicinal properties of the water.

In the following table is given a list of the springs that reported sales of mineral water during 1907, together with a statement regarding the number of guests that can be accommodated at the springs:

Spring and Address.	County.	Number of Guests Accommodated.
All Healing Spring, Taylorsville.....	Alexander.....	50
Barium Rock Spring, Barium Springs.....	Iredell.....	
Buckhorn Lithia Spring, Bullock.....	Granville.....	
Connelly Spring, Connelly.....	Burke.....	150
Haywood White Sulphur Spring, Waynesville.....	Haywood.....	250
Jackson Spring, Jackson.....	Moore.....	200
Mida Spring, near Charlotte.....	Mecklenburg.....	
Morris Spring, Morris Springs.....	Stokes.....	450
Mount Vernon Springs, Mount Vernon.....	Chatham.....	100
Panacea Springs, near Littleton.....	Halifax.....	
Seven Springs, near Goldsboro.....	Wayne.....	100
Thompson Bromine-Arsenic Spring, Crumpler.....	Ashe.....	75
Vade Mecum Spring, Vade Mecum.....	Stokes.....	450

The Cleveland Spring, of Shelby, Cleveland County, which was a producer in 1906, did not report any production in 1907, while the Mount Vernon Springs reported a production for the first time in 1907.

In the following table there is given the quantity and value of mineral waters shipped for the years 1901 to 1907, inclusive:

PRODUCTION OF MINERAL WATERS IN NORTH CAROLINA
SINCE 1901.

Year.	Amount, Gallons.	Value.
1901.....	375,700	\$ 42,167
1902.....	104,400	18,795
1903.....	83,100	13,085
1904.....	145,800	21,902
1905.....	201,000	38,755
1906.....	158,680	31,413
1907.....	193,479	40,302

GRAPHITE.

The production of graphite in North Carolina has always been small and has never amounted to more than a few hundred tons per year. Its use has been for foundry facings and it is of rather inferior quality. During the past year, 1907, no graphite whatever was shipped. In the following table there is given the production of graphite from 1901 to 1907, inclusive:

PRODUCTION OF GRAPHITE IN NORTH CAROLINA FROM 1901
TO 1907.

Year.	Quantity.	Value.
	<i>Tons.</i>	
1901.....	95	\$ 559
1902.....	830	4,300
1903.....	50	248
1904.....	100	525
1905.....	100	475
1906.....	100	475
1907.....		

COAL.

The coal deposits have been described in some detail in previous reports and at no time has the production been of any large amount. In 1906 and 1907 there was no production whatever. In the table below the coal that has been produced in North Carolina since 1890, when the Cumnock Mine was reopened, is given:

COAL PRODUCTION IN NORTH CAROLINA FROM 1890 TO 1907.

Year.	Quantity.	Year.	Quantity.
1890.....	10,262	1899.....	26,896
1891.....	20,355	1900.....	17,734
1892.....	6,679	1901.....	12,000
1893.....	17,000	1902.....	23,000
1894.....	16,800	1903.....	17,309
1895.....	24,900	1904.....	7,000
1896.....	7,813	1905.....	1,537
1897.....	21,280	1906.....	0,000
1898.....	11,495	1907.....	0,000

PEAT.

Considerable interest has arisen during the past few years regarding the peat deposits in North Carolina in respect to their value for fuel, fertilizer and other purposes. As yet it has been impossible for the Survey to make any extended investigation regarding these deposits, but a small beginning was made in 1907 under the direction of Mr. Charles A. Davis, of the U. S. Geological Survey. In connection with his work, arrangements were made by which two car loads of peat were shipped from deposits on the outskirts of Elizabeth City, Pasquotank County, to the U. S. Geological Survey Fuel Testing Plant at the Jamestown Exposition, where it was tested. The results of this examination show the peat compares very favorably with peat that is being used for fuel purposes in Canada and European countries. It was hoped that there would be sufficient of the peat to make a producer gas test, but it was not possible to have this made. There is given in the following pages Mr. Davis' report:

PRELIMINARY REPORT OF PEAT DEPOSITS IN NORTH CAROLINA.

BY CHAS. A. DAVIS.

During the months of July and August, 1907, while making a preliminary study of the peat deposits of the coastal plain for the U. S. Geological Survey, a hasty examination of several localities in the sound region of North Carolina was made by the writer to determine, if possible, something of the origin and of the quality and quantity of peat in the well-known and extensive swamps of this part of the State.

Unfortunately, the work was not begun early enough to make a complete survey, but enough was done to make it apparent that in the region visited there are some deposits of sufficient extent and depth to serve as possible sources of large quantities of fuel, or as the basis of other industries.

In addition to this, sufficient data relating to the origin of the peat beds were collected to indicate the kinds of places to be examined for other deposits of sufficient depth and of the proper composition to make them of economic importance.

In recent years the constantly advancing price of coal and the increasing difficulty of getting a sufficient supply of either coal or wood for fuel, for industrial and domestic uses, has led to the seeking out of other sources of fuel supply, and among those which appear most promising is peat. It has for a long time been the most generally used fuel among the people of northern Europe, but in this country it is still practically an unknown, or at least undeveloped, resource.

Peat described.—Peat is partly decomposed vegetable matter which is accumulated in places in which the ordinary decay or decomposition of such materials is arrested, while the form, and a considerable part of the structure, of the constituent vegetation is more or less completely lost. Water, by excluding air and a large number of organisms which cause wood and other plant structures to rot and finally disappear altogether, makes an excellent medium for the accumulation of peat, and in general it may be said that peat deposits are only formed in places where there is a permanent or nearly permanent supply of water, which either completely saturates or covers the accumulated plant debris as laid down.

Deposits of such plant material, which, while kept wet part of the time, are subjected to periodical drying out, do not form peat, but may

form the related substance, humus, which is of such importance in all agricultural lands as a source of plant food and as a conserver of moisture.

Peat may be described, then, as the brown or black material of vegetable origin which is found in all places where the ground is continually saturated by water. It varies in color from light brown to black, and in texture from incoherent, loosely-felted material, coarse and fibrous or even woody, to a nearly structureless, cheesy mass, which is nearly as plastic as clay or putty. In all cases, under natural conditions, peat is saturated, or nearly saturated, with water containing from 80 to 95, or even more, per cent of this substance. Dry peat is lighter in color than wet, and will usually float when placed in water, although this is not always true of some darker colored, plastic types, which become nearly as hard as stone when dry. Except for these, untreated dry peat is quite easily crumbled to powder when handled, and makes bulky and unsubstantial fuel which does not bear transportation well.

OCCURRENCE.

Peat occurs in all of the moist regions of the earth, but is most generally distributed where the rainfall is regular and abundant, and where the relative humidity of the atmosphere is constantly high, so that evaporation of the water from the land surface is reduced to a minimum. A third important factor favoring peat accumulation is the presence of numerous undrained depressions in the land surface in which water stands permanently, at a nearly constant level.

These conditions are most fully met in the cold-temperate regions of the earth, especially in the northern hemisphere, where there are extensive land masses with poorly drained surfaces because of their comparatively recent abandonment by the ice sheet of the Glacial Period of geological history. In North America, north of 40° north latitude, conditions such as have been described are general; hence peat is more abundantly and widely distributed in that portion of the continent than south of it, and in Canada thousands of square miles of land are covered to a considerable depth by peat, and the States along the boundary between the Dominion and the United States all have, in the aggregate, large areas of peat deposits.

Southward of these States, the higher temperatures, longer summers, more frequent droughts and absence of undrained depressions produce conditions unfavorable for peat formation, and deposits of this material are fewer and of less extent than farther north. A very important factor in this respect is the low relative humidity of the air for long

periods during the summers, which tends to keep the surface of the land constantly dry, and thus in such a state that peat cannot collect upon it, even though the vegetation is luxuriant.

In the coastal plain, however, even in the extreme south, there is a very heavy rainfall, and the relative humidity of the air is generally high; that is, the air has apparently all of the moisture it will hold, because of the nearness of the ocean, and a general local movement of the air from the sea towards the land.

These conditions increase the rainfall and check evaporation, both factors advantageous to the accumulation of peat. The unfavorable condition existing here, aside from occasional summer droughts, is the almost entire absence of undrained depressions. This is offset, however, by the fact that the shore region of North Carolina is recently elevated sea bottom, almost without relief forms of any sort, great areas of the land being so nearly level that the water which falls as rain is unable to drain away rapidly enough to prevent swamp conditions from arising. This, together with the other factors mentioned, makes peat formation possible, despite the general absence of depressions noted above.

Peat formation in the coastal plain—The Pocosons.—The peat on these flat, undrained plains was probably formed somewhat as follows, judging from the studies made of existing conditions in the tracts visited: The earliest vegetation to establish itself was grass-like. This, by its growth and partial decay, tended to hinder still further the draining away of the rainfall, so that marsh plants soon appeared on the wet soil. These were of the grass type also, sedges, rushes and other herbs with long, narrow leaves and vigorous horizontal underground stems and abundant roots, which made a compact turf. The ground-surface was slightly raised by this, and, during dryer times, shrubs and trees gained a foothold upon it and sent their roots through the turf into the underlying mineral soil and made vigorous growth.

Upon the return of wet conditions, some of the types of woody plants were doubtless destroyed, but some, such as the cypress, sour gum and other species which will grow in excessively wet soil, persisted; those which were drowned out contributed to the ever-increasing accumulation of water-soaked vegetable matter and helped to check the run-off of the surface water.

The stages of development were doubtless quite varied, according to the size and elevation of the original area, its soil structure and slope, its distance from the margin of the ocean and the species of plants which were able to become the leaders in the plant association which originally took possession of the plain. It seems certain, however, that

a stage similar, or equivalent to, the open pocosons, known locally as "open grounds," now existing near the shores of the sounds, must have been passed through. Of these, the earliest observed stage was not far from Beaufort, near Wit post office. The chief vegetation here was a vigorous growth of sedges, grasses and other herbs, mingled with low shrubs, chiefly heaths growing in a substratum of sandy peat, covered by a dense growth of sphagnum moss. Forming clumps, or densely covering large areas, especially near the margins, were taller shrubs, also of the Heath family, bound together by a tangle of green brier and other vines, and growing over all, except for a large area in the most poorly drained parts, towards the center, was a sparse, open growth of the stunted Pond Pines. Towards the sound was a broad border of salt and brackish marsh without true peat. Examples of this type of pocoson are fully described by Ashe* in a previous report of this Survey.

The depth of peat in the areas visited was somewhat less than 4 feet. The peat was black, quite sandy, and of little prospective commercial value as fuel, since the sand would much reduce its heating value. A later stage of this type seemed to have a much more abundant growth of shrubs and broad-leaved trees, bound together by vines of several species, while the herbs and moss were less conspicuous and the pines larger and more thrifty in appearance. This stage, however, may have been due to less frequent fires, which in dry times often run through these swamps. Even if this is the cause of the difference in appearance between the stages, the facts noted are significant, in that they point to a definite and well-defined succession of types of plants, the earliest to appear being of the kinds which make the best peat.

The final or climax stage of this series of swamps formed on flat plains, which indefinitely repeats itself over and over, building up layer upon layer of the same sort of peat, seems to be a densely tree-covered, more or less wet swamp, in which locally the vegetation presents considerable variety, but with broad-leaved trees generally the dominant types, especially the sour or black gums, the red maple and the swamp oaks. The cypress is often distributed among the other types, but is frequently not present, or only in very wet places. The same statements may be made for the white cedar or juniper (*chamaecyparis thyoides*), which in some places forms dense, pure stands, in others is scattered through the hardwood growth, and in still others is entirely wanting. Below the trees, growing on the elevations around their root crowns and on fallen logs, will often be found shrubs, vines and the cane with lower-growing herbaceous plants.

*W. W. Ashe in Biennial Report of the State Geologist, 1905-06, pp. 40-46.

In some of these swamps peat occurs, but it is usually shallow, even in the Great Dismal Swamp, the most extensive of this type having rarely a depth of more than 6 feet, and is full of roots, fallen logs and the partially decayed stumps of past generations of dead trees. In the juniper swamps the number of buried logs is so large and their state of preservation so good that they have been dug out and used for lumber, and the peat in such swamps is reported to be little else than a mass of roots and logs lying together in a tangled mass.

Because of this structure and the shallowness of the beds of peat which have been formed in these coastal plain swamps, little can be expected of them as a basis of commercial development of fuel or other industries, except on a very small scale, perhaps, for local use, since the cost of digging out the peat and preparing it for market would be prohibitive.

More thorough investigation of some of these swamps may develop the fact that there are limited areas in which peat of better quality and greater depth exists. This is hardly to be expected, however, as both the geological structure of the country and the laws governing the growth of the plants which have formed the peat are opposed to such a possibility. The conditions have been such that tree growth began early in the history of the development of the peat and has been continued till the present time. Doubtless, in many cases it preceded it, and by shading the soil and keeping it wet, has contributed indirectly to peat formation as well as directly by furnishing a considerable part of the vegetable matter which has been preserved as peat. In numerous instances confirmation of this may be seen now around the outlying borders of most of the peaty areas, where the trees are well established under swampy conditions without any deposit of peat having formed.

The timbered pocoson, in which no peat has yet appeared, is a variant from the type, which doubtless will change into a peaty area as the accumulation of vegetable matter reaches such a point that the water is no longer able to drain off from or into the soil. At present, the vegetable matter falling to the ground is so often and so thoroughly dried and aerated that the organisms producing decay convert it into humus; but as this may accumulate faster than it is dissipated, in the end a condition of permanent wetness would be induced and peat formation would begin. This seems to be the condition on the western side of the Great Dismal Swamp in Virginia, where, at the outer edge of the swamp, there is no peat accumulation, but a mile or more into the swamp shallow peat is pretty generally present. The same thing was noted in the vicinity of Belhaven and near Newport, and is doubtless

generally to be observed around the margins of the greater swamp areas. In the smaller swamps drainage may be sufficient always to keep the average conditions such that no peat forms, although there may be prolonged wet periods which maintain the general swamp conditions.

The Marginal Swamps.—This name is given to a type of peat accumulations which are peculiar to the coastal plain and were first studied by the writer near Elizabeth City, where just north of the town, on the line of the Norfolk and Southern Railroad, is an excellent example.

Such swamps are marginal to the sounds, or the estuaries of the streams flowing into them, and have peaty deposits underlying them to a much greater depth than do the pocosons. The observed examples of the kind under discussion seemed to have formed in slight indentations of the shore line on which they occurred. These were long in proportion to their width, which was not very great.

The peat in the deposit at Elizabeth City was more than 16 feet deep and, where tested, had the following structure:

Record of a boring in the peat deposit north of Elizabeth City, in the open marsh near a sawmill siding: Surface growth, shrubs, sedges, saw-grass and cane.

- 0-2 feet—Turf of sedge roots and stems, tree and shrub roots, etc.
- 2-2 1/2 feet—Soft, brown peat with many bits of wood.
- 4-4 1/2 feet—Soft, brownish-black peat, well decomposed, plant remains, roots and stems of sedges and of yellow water lily.
- 6-6 1/2 feet—Soft, brownish-black, well-decomposed peat, with parts of cane leaves and rootstocks.
- 8-8 1/2 feet—Dark-brown, plastic, well-decomposed peat, with bits of grass-like plants. Hydrogen sulphide odor strong.
- 10-10 1/2 feet—Plastic, dark-brown, somewhat silty peat; cane or grass rootstocks and fragments of water plants.
- 12-12 1/2 feet—Plastic, dark-brown peat, containing cane rootstocks.
- 14-14 1/2 feet—Good, plastic, dark-brown, fine-grained peat, fragments of leaves of water plants.
- 16-16 1/2 feet—Plastic, dark-brown, fibrous peat, with strong odor of hydrogen sulphide; no wood or silt.

Most of the section gave an odor of hydrogen sulphide and considerable of the gas came up through the test holes. No wood or logs were encountered and very little silt was found in the samples. Several other tests were made, with about the same results, except that occasionally at a number of stations wood was found at various depths. Well-preserved cane remains were also common to the limit of the soundings—about 17 feet below the surface.

ECOLOGICAL AND GEOLOGICAL SIGNIFICANCE OF THE MARGINAL SWAMPS.

The character of the recognizable plant remains in the material found in these borings gives evidence that the deposition occurred under conditions which must be interpreted in one of two ways, namely, that there had been a very slow but constant rise of the level of the water while the peat was building up, or that the land under the deposit was slowly subsiding while peat formation was progressing. Of these two hypotheses but one is tenable, since the water in question is directly connected with that of the ocean and it is definitely known that the surface of the ocean has not generally risen to the extent required to account for the peat accumulations under consideration.

The other alternative—the slow subsidence of the bottom as the peat was growing—must be accepted, and as this is in accordance with other well-known geological evidence, such as submerged valleys, the washing away of beaches and minor changes in the coast line from Long Island southward, it may be considered as proved that the peat in the marginal swamps has reached the depth which has been found, because the bottom upon which it has been building has sunk to that depth. Thus, the peat of these swamps is a measure of the actual amount of subsidence and of the rate of sinking.

The laws governing the growth of plants are such that each species is able to grow only where its roots can get a certain amount of air and water and its leaves a certain amount of light. If the roots of most land plants are submerged too deeply in water the plant dies, largely because the air is cut off from them, and even swamp plants are so nicely adjusted in their relations to the water level that a rise of the water a foot in the soil may very largely destroy certain species. This may be illustrated by the great areas of the common cane which, in a dead and dying condition, were seen by the writer in the Great Dismal Swamp during the summer of 1907. There had been a prolonged period of high water in the parts of the swamp where the cane was injured, and it had been unable to survive it.

Other plants are equally sensitive to similar changes. Hence, if it is found that throughout the peat there are well-preserved and perfectly recognizable characteristic parts of plants whose relation to the water level is certainly known or can easily be ascertained by an examination of the living plants on the surface of the swamp, it is evident that the fact may be safely deduced that water levels were about as they are at present during the whole time while the peat formation was going on. This could only mean that the rate of subsidence was equal to the

rate of building up by the plants, and, since the same species were recognized from top to bottom, it is also apparent that the climatic and other environmental conditions have been about uniform.

It would therefore be possible to use these deposits to measure the lapse of time since the formation of the peat began, and, with less certainty, perhaps, the length of time during which subsidence in this area has been in progress, for it would be merely a matter of determining by observation for some years the rate at which the peat is growing at present and use this as a divisor into the total depth to find the length of time it has taken the whole to grow. A uniform rate of subsidence is shown by the uniformity of the constituent plants of the peat.

Such peat beds, then, may become the most definite and exact measures which have yet been found for determining the rate of the coastal subsidence and the length of time it has been in progress without a halt. If other evidence of the subsidence of the coastal plain were needed, that afforded by the living vegetation along the sounds where the water is fresh enough—as, for example, the shores of Albemarle Sound at Edenton and Mackey's Ferry—is conclusive. In this region on both shores are numbers of cypress trees growing in the open water of the sound at considerable distances from the shore. These trees are of rather small size and cannot be of very great age, yet it is certain at the time when they started from the seed they were on soil which, while it may have been near the water level, was not permanently below it; therefore, it is evident that the coast has sunk during the lifetime of these trees an amount at least equal to the difference between the mean high-water mark and the level of the early roots of the trees—a matter of several feet.

As above stated, the peat of the beds at Elizabeth City was compact, plastic, nearly black near the surface, but dark-brown below a depth of two or three feet, becoming blackish after a short exposure to the air. The structure of this deposit was quite uniform where tested, except for the partially decayed logs found here and there. These did not seem numerous enough to affect the value of the peat, however, and in most places none were encountered.

EXPERIMENTAL USE OF ELIZABETH CITY PEAT BY U. S. GEOLOGICAL SURVEY.

A quantity of this peat, amounting to several car loads, was dug out and sent to the fuel-testing plant of the Technological Branch, U. S. Geological Survey at the Jamestown Exposition. The peat was received at the Exposition grounds in the wet state, as dug from the bog, and was run through a peat press of German construction which ground and compacted it and formed it into bricks having a cross-section

of about 3 x 4 inches when wet, but shrinking about one-quarter on drying. These bricks were then dried by exposure to the air, becoming quite firm and tough when dry.

A preliminary proximate analysis made by the writer gave the following as the composition of this peat. The sample analyzed was taken from about 4 feet below the surface and was dried carefully at 100° C. before analysis.

Analysis of Peat from Elizabeth City, N. C.

Volatile matter	67.41 per cent.
Fixed carbon	23.74 per cent.
Ash	8.88 per cent.
B. T. U. (fuel value) not determined.	

This compares well with peat from other regions, being neither so good nor so poor as some, but is good fuel if properly prepared.

Several swamps of the same, or very similar, character were seen in the sound region, but were not examined for peat. There seems no good reason, however, why these should not have peat deposits of the same nature and origin as the one described. Such swamps were observed both north and south of Elizabeth City, and near Edenton, and these were all quite favorably situated near the line of the Norfolk and Southern Railroad, in case examination shows that they contain peat in sufficient quantity and of the right quality to warrant the development of fuel or other industries upon them.

This type of peat deposit has much greater commercial possibilities than that which occurs in the *pocoson* type of swamp, since the beds can be deeper, and are likely to be freer from tree remains. On the other hand, however, care should be taken in prospecting to avoid swamps which have been exposed to flooding by storm waters containing much sand or mud, or those near the mouths of streams which in flood time bring down large quantities of silt and mud and deposit them in the swamps, as from these sources the peat may become too high in ash to be of any value as fuel. For the same reason the swamps which have developed along the flood plains of rivers and on the delta deposits at their mouths are not likely to contain peat which can be used as fuel, especially where the streams are heavily charged with silts, as is the case with most of those in the region under consideration.

It is evident from the foregoing discussion that all gritty or sandy peats, or those made up largely of woody plants in which the wood is not thoroughly broken down by decay, are to be considered as unavailable at present for fuel purposes.

USES OF PEAT.

Fuel.—Peat has been used for fuel more than for any other purpose, and certain kinds of it are unsuited for any other use. As a fuel, it is highly satisfactory for cooking and heating stoves, as it is clean, light in weight, and with properly regulated drafts and suitable grates it burns freely, giving an even, intense heat, with little objectionable smoke and no cinders, clinkers or corrosive effects on grates or fire boxes. It also burns for a very long time—until it is entirely consumed, in fact, when deprived of draft. The ash is bulky but light in weight, and although it varies much in different kinds of peat, those which have 20 per cent or over are not considered sufficiently high in heating power to be worth trying to make into a commercial product. Such would still be usable for fuel by individuals on a small scale or for peat gas.

Peat is also a good fuel for use under steam boilers, requiring for the best results, when used for this purpose, rather larger fire boxes and less grate space than either wood or coal. When freshly fed to the fire under boilers it burns with a clear, bright, nearly smokeless flame of intense heat, and, after the gases are all consumed, continues to burn with a steady, strong heat until it is wholly used up. The same advantages are claimed for it in steam and power production as in domestic uses, the only drawbacks being its bulkiness, as compared with coal, since several times the space and storage is required for it as for coal of the same heating value, and the more frequent firing necessary. These are more than offset, however, by the ease of handling, the absence of clinkers and waste and the freedom from smoke and corrosive gases.

Cut peat.—The form of peat fuel which has been in general use for generations among the people in most countries of northern Europe is cut peat. The only preparation given this is to cut it from the bog in oblong blocks with the slane, a tool like a long spade, with a sharp, cutting spur a few inches long welded at right angles to the bottom, and to expose it to the sun and air until it is dry enough to pile in open stacks.

Machine peat.—In order to increase the fuel value of this product, which is somewhat higher than that of wood, and at the same time to secure a more compact and less friable fuel, many types of machinery have been devised during the past century. The simplest and least expensive of these, and perhaps the most efficient as well, grinds the peat, wet, as it comes from the bog, kneads and compacts it and forces it from the outlet in a long prism or cylinder which is cut into bricks and delivered on pallets or short boards as fast as made. These are

taken to drying grounds where, in a short time, they become sufficiently firm to handle and may be stacked and left to dry more completely. Such air-dried blocks make a good fuel, considerably superior to wood in heating value, and may be readily handled without breaking. Fuel thus prepared is known as machine, condensed, or compressed peat, although little compression is used in its preparation. The grinding and kneading to which it is subjected in the machine reduce the volume of the crude peat about one-third.

The processes described above can only be carried on during the summer months in northern climates where they have been developed, and it is especially desirable to continue the making of peat into fuel during the entire year, since then the plant and men employed will not be idle for any long period. Many attempts have been made, therefore, to devise some process by which the peat can be dried artificially and converted into a compact form, regardless of wet weather and of the seasons. By this means also it has been hoped to develop a continuous output of high-class fuel sufficient to warrant the investment of large capital. Unfortunately, however, the very large per cent of water held in peat is so tenaciously retained by it that it is only given up by the application of heat; pressure, filtering and other means usually employed to separate solids from liquids have little effect to free the peat from water, as has been proven abroad by exhaustive and costly experiments on a factory scale.

Peat briquettes.—After the peat has been artificially dried and powdered, it may be compressed into blocks of various convenient shapes by the application of great pressure. Such blocks, known as peat briquettes, have a considerably higher fuel value than either cut or machine peat, are more compact, firm and easier to handle than blocks of other types, and at the same time they do not disintegrate readily in the fire, or when exposed to a moderate amount of wetting, but may crumble if handled roughly. In this form peat is at its best, but, unfortunately, all of the plants established in this country to manufacture peat briquettes using the artificial drying system have been unsuccessful, and those abroad are reported by careful and competent investigators of the subject as not flourishing. This is undoubtedly due to the amount of fuel needed to drive the water out of the peat. The importance of this item is evident when it is understood that about three times the number of heat units must be used to produce a ton of dry peat as the ton will generate after drying, so that even if the fuel consumed for the purpose is waste material from the bog, a great amount of it must be gathered in proportion to the salable product

made; and the latter will not sell for sufficient to pay for this and its own preparation and selling, together with the cost of maintenance of the expensive plant necessary for its manufacture.

Peat coke.—Still more expensive is the plant necessary for the manufacture of peat coke, the form of peat fuel approaching nearest to anthracite coal in efficiency. This material, when made by the best processes, is as firm and hard as hardwood charcoal and is quite as valuable as that material for all metallurgical operations, such as smelting iron, copper and other ores, as well as for fuel purposes. In the production of peat coke by a recently developed commercial method—the Ziegler process—the peat is ground wet, formed into bricks and air-dried; it is then heated in closed iron retorts, the inflammable gases driven off being burned under the retorts to carry on the process, while the gases which will condense are saved; from them, by special treatment, are derived wood tar, methyl or wood alcohol, acetic acid, ammonia compounds, illuminating and lubricating oils. This process is fully covered by patents abroad and in this country and requires a considerable outlay of capital for even the smallest unit plant.

Comparison with other fuel.—For the purpose of comparing the fuel value of peat which has been given the various methods of treatment described above with other common types of fuel the following table is inserted. In considering the table, however, it should be remembered that the samples of peat given are not from the same source, and hence the relative values are only approximate.

COMPARISON OF HEAT VALUE OF VARIOUS FUELS.

Fuel.	B. T. U.
Wood.....	5,760
Ordinary air-dried cut peat.....	6,840
Pressed peat.....	7,290
Bituminous coal.....	11,000
Ordinary gas coke.....	12,000
Peat coke.....	12,676
Semi-bituminous coal.....	13,000
Peat briquettes.....	13,330
Charcoal.....	13,804
Anthracite.....	14,600
Peat coke, No. 1 (Ziegler process).....	14,800

The quantity of fuel used in these tests was 1 pound. The British thermal unit (B. T. U.) is the amount of heat necessary to raise a pound of water 1 degree Fahrenheit.

Figures of the American Society of Mechanical Engineers are, 1 ton anthracite equals 1.8 tons common air-dry peat or 2.5 tons pine wood. Air-dried peat has from 12 to 25 per cent water and loses about 1 per

cent of its heating value for each per cent of moisture which it gains. All forms of peat fuel, except the charcoal and coke, and possibly some very dense, black peats, take up moisture from the air until about in air-dry condition, hence are less efficient in very moist air than in dry.

Peat gas.—Peat yields a large amount of combustible gases compared with coal, when heated in retorts, and in Sweden and some other parts of northern Europe it is reported to be used for the production of illuminating gas on a large scale, even low-grade peat high in ash giving excellent results. The gas may be used in gas engines, seeming especially adapted to this use, and it has been proposed by European engineers to employ it by means of gas engines at the larger bogs to generate electricity for power and lighting, transmitting the current to manufacturing centers for use—a perfectly feasible plan if experiments confirm the theoretical possibilities.

Peat is a fuel which may be used in the suction types of producer-gas engines, comparing very favorably with some of the poorer bituminous coals for this purpose and yielding much more power used thus than when burned to generate steam. The use of all kinds of low-grade fuels in the producer-gas engine is, however, subject to certain disadvantages, which, up to the present writing, are only partially overcome, and it is only in large plants where competent mechanical engineers can be employed that such fuels are being tried.

Peat in agriculture.—Peat is perhaps of more importance in its agricultural uses than in any other, not excepting fuel. This is especially true in a region where soils are light and sandy and easily leached, as in much of the coast and trucking regions of North Carolina, where it is necessary to keep the land in a state of highest fertility to get the best results from the special crops which are raised. Peat in the raw state, as it comes from the bog, has little, if any, value when spread wet on the surface of the land, since it soon dries and forms hard lumps of inert organic matter which do not subsequently pulverize. If, however, it is cut out from the swamps and piled in heaps during the winter and allowed to stand till thoroughly dry and disintegrated and is then composted with stable or barnyard manure, it becomes a valuable material, furnishing a good absorbent for the liquid and gaseous parts of the manure and also for the ammonia compounds which would otherwise be lost. At the same time, a part of the 2 or more per cent of fixed nitrogen of the peat, entirely inert in the crude peat, is made available for the use of plants, and the whole mass becomes more or less converted into humus-like compounds, the thoroughness of these changes, however, depending somewhat on the type of peat originally used. One careful experimenter in this direction reported, after many tests, that

he considered a load of peat thus treated to be equal to a load of stable manure, and farmers in the regions where peat is common have long known that no better material could be found for use in barnyards as an absorbent. The chief sources of error in the use of the material lie in trying to use it for any such purpose in the wet and unmodified condition. The fallacy of drawing wet peat for the above use is shown when it is remembered that about 90 per cent of its weight is water, and that at least from one-half to two-thirds of this weight will disappear after the material has been heaped up on the surface of the ground for a sufficient time, while its mechanical and absorbent properties, as well as its chemical, are much improved by this treatment.

Peat as stable litter.—The coarser, less thoroughly decomposed kinds of peat, especially those in which mosses and grass-like plants form a large part of the material, make excellent stable litter and bedding for horses and cattle, being cheaper and much more absorbent than straw, and having a deodorizing and antiseptic effect not possessed by the usual materials. These properties render the peat litter especially valuable for use in dairy barns and in city stables. The moss-covered, "open grounds" in pocosons near the railroads, like that near Newport, for example, should be examined with a view to determining whether the moss could not be raked up and baled for litter for shipment to the cities farther north.

Peat as a deodorizer and disinfectant.—Dry, powdered peat is a most efficient deodorizer for use in cesspools, privy vaults, earth closets and urinals, excelling dry earth, ashes, or even lime in this respect. For this purpose it should be dried as thoroughly as possible and stored in barrels or bags under cover. In Europe, the finer material, obtained by screening out the coarser moss and other plant remains in preparing the peat litter for baling, is saved and sold for the above-mentioned uses, and machines for separating the two products automatically and delivering them to the packers are manufactured.

Peat filler for artificial fertilizers.—A rather recent use of peat on a large scale has developed in the manufacture of peat as a "filler" for those forms of artificial fertilizers in which tankage and other refuse animal matter is used as the source of a part, or the whole, of the nitrogen. For this use the peat is dried and pulverized and in this form is the best material yet found for mixing with the substances mentioned above; its absorbent qualities permit it to keep the mixture dry and thus prevent caking, and its antiseptic effects also probably prevent destructive bacterial fermentation and the loss of the nitrogen as free ammonia. If free ammonia is liberated, the peat, in part at least, may absorb it; and not the least of its valuable qualities in this

use is its deodorizing effect. On the other hand, the peat itself is not directly and immediately a fertilizer under ordinary conditions, since it will be slow to decompose; its 2 to 3 per cent of nitrogen, in combined form, may also appear in the analysis of the fertilizer and thus "pad" it, since it is in such combinations that it is not available for plants. In spite of these objections, its numerous and weighty advantages and its cheapness, together with the fact that ultimately it probably becomes a part of the humus of the soil and thus enriches it, make its use not only justifiable but almost necessary, if the cheap sources of nitrogen are to be fully utilized in the manufacture of the fertilizers, so important to the best interests of the agriculture of to-day.

Most of the dark-colored peats of the marginal swamps could be used for this purpose, and the simplicity of the process of preparation, the nearby markets and the excellent facilities for both land and water shipment should lead to an early development of an industry of this character upon some of the North Carolina peat beds.

Other uses of peat.—The uses of peat in paper and cardboard manufacture, fabric-making and some others need not be discussed here, since they require types of peat for their development which do not seem to be likely to be found in the coastal plain, since conditions are adverse to their occurrence.

Prospecting methods.—In the preliminary testing of a peat deposit the essential things to be considered are quantity, quality and availability. The quantity can be determined approximately by estimating or surveying the surface covered by the deposit and getting the average depth by borings made with a common two-inch ship auger welded to a short piece of one-half inch gas pipe. This should be fitted with a union so that it may be screwed to other sections of pipe and pushed down until the bottom of the peat is reached. If the rod is to be much used, sections should not exceed 4 feet in length, and each union should be permanently pinned to a section so that only one end will unscrew. The testing with the auger should be done systematically in straight lines, holes being made at approximately regular intervals and their location noted on a sketch map, together with the depth of peat.

Valuation of peat beds.—To estimate the quantity of dry fuel which can be made from a given deposit, conservative figures would be from 200 to 300 tons per acre for each foot in depth below the surface 2 or 3 feet. The quality of the peat is of equal importance to the quantity, since upon this depends the use which can be made of it. By quality may be understood the physical structure and chemical composition. Very coarse, woody, or poorly decomposed peat, or that which is very

sandy or muddy is not physically adapted to any use under existing conditions. Types of peat with much grass and sedge remains in them, while making good fuel by the wet process and by coking are not usually adapted to briquetting. The fuel value, ash and composition of the peat, can only be determined by chemical analysis, but besides the analytical study, before it is decided to build a plant at any peat deposit, large samples of the material should be tried to test its adaptability to the particular purpose for which it is intended to be used.

In selecting peat beds for exploitation the matter of markets and of transportation to them should be thoroughly considered, for the product, however desirable it is theoretically, must find a sure market and be delivered to it regularly and cheaply if the manufacturer is to make profitable sales. Peat fuel must be sold in competition with coal and wood, hence it must be disposed of at a moderate price. It is bulky and easily broken into fragments, so cannot be transported either by cart or rail very far over rough roads; it is injured by long exposure to rain, therefore it requires protection from the weather when stored or in transit. For these and other reasons the matter of market and transportation are paramount considerations, and otherwise most excellent deposits must remain unused because too remote from good markets, or from established transportation lines.

CONCLUSION.

The present outlook for peat, especially as fuel, seems to be in the careful development of small establishments to supply local demands wherever the price of other fuels is sufficient to warrant the introduction of a moderate-priced fuel adapted especially to domestic use. If such plants are properly planned and have good transportation facilities, they should be financially successful, as in such peat fuel can be produced ready to ship by the wet process for about \$1 per ton. If improvements are made in producer-gas engines so that small manufacturers can install and use them economically, using low grades of fuel, immediately a larger opportunity for peat fuel will be presented. In whatever direction utilization of the peat deposits of the State is begun, the work should be carried on carefully and as an experiment until sufficient knowledge of the markets and of the ways of handling the substance itself is acquired to insure success, for, judging by the failure of the plants in other States, in no other way can it be achieved.

STONE.

The production of building stone in North Carolina has been constantly increasing for the past twelve years, and during 1907 there was

a decided increase in the value of stone produced as compared with that of 1906, the total value of the production of all kinds of stone being \$956,919, which is an increase of \$102,618, as compared with \$854,301, the value of the production of 1906. Each year there is a greater amount of the stone produced used for building purposes and its market is being more widely extended. This is true not only of the stone for building, but also of the curbing and paving blocks for street work.

There is given in the table below the value of the production of various stones produced in North Carolina for the years 1900 to 1907, inclusive:

PRODUCTION OF BUILDING STONES IN NORTH CAROLINA, 1900-1907.

Year.	Granite.	Sandstone.	Marble and Limestone.	Total Value.
	<i>Value.</i>	<i>Value.</i>	<i>Value.</i>	
1900.....	\$ 257,962	\$ 27,210	\$*-----	\$ 285,172
1901.....	264,906	11,682	8,357	284,945
1902.....	338,749	4,825	23,153	366,727
1903.....	334,357	600	25,365	360,322
1904.....	292,439	250	19,887	312,576
1905.....	564,425	4,482	29,015	597,922
1906.....	778,819	3,431	72,051	854,301
1907.....	906,476	4,105	46,338	956,919

* Statistics not collected for 1900.

GRANITE.

PRODUCTION.

The increase in the production of granite which has been noted for a number of years past, continued in 1907, and the value of the production, \$906,476, is an increase of \$127,657, as compared with \$778,819, the value of the 1906 production. The number of operators quarrying granite during 1907 was 33, an increase of 8 over the number quarrying during 1906. These operators worked 37 quarries in the following 16 counties, which are given in the order of the importance of their productions: Rowan, Surry, Rockingham, Warren, Buncombe, Polk, McDowell, Orange, Henderson, Vance, Nash, Guilford, Wake, Davidson, Anson and Gaston. Cabarrus and Catawba counties, which were producers in 1906, reported no production in 1907, while Anson, Guilford, Nash and Wake are added to the list of producing counties.

Nearly one-half of the granite production of 1907 was used for building and monumental purposes, amounting to \$432,913. This is an increase of \$57,839, as compared with the value, \$375,074, of the 1906 production.

There is given in the following table the uses and value of granite quarried from 1901 to 1907, inclusive:

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901-1907.

Uses.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
Building and monumental purposes.....	\$108,574	\$167,639	\$127,486	\$75,632	\$312,362	\$375,074	\$432,913
Paving blocks.....	10,662	6,986	30,780	15,807	48,234	33,428	65,379
Curbing and flagging.....	56,245	82,615	68,099	101,632	74,307	138,090	66,967
Crushed stone for road-making, railroad ballast, etc.....	89,425	77,759	102,524	93,296	118,470	228,429	336,657
Other purposes.....		3,750	5,468	6,072	11,052	3,798	4,560
Total value.....	264,906	338,749	334,357	292,439	564,425	778,819	906,476

The next table gives the value of the granite produced from 1897 to 1907, inclusive, and shows very strikingly the remarkable growth of this industry in North Carolina:

PRODUCTION OF GRANITE IN NORTH CAROLINA, 1897 TO 1907.

Year.	Value.
1897.....	\$ 59,236
1898.....	79,969
1899.....	225,544
1900.....	257,962
1901.....	264,906
1902.....	338,749
1903.....	334,357
1904.....	292,439
1905.....	564,425
1906.....	778,819
1907.....	906,476

SANDSTONE.

PRODUCTION.

There was but little change to be noted in the sandstone industry in North Carolina during 1907. The production was small and was used largely for building purposes. The value of the production amounted to \$4,105, an increase of \$674, as compared with \$3,431, the value of the 1906 production. There is given in the following table the value of sandstone produced in the State for the years 1897 to 1907, inclusive:

PRODUCTION OF SANDSTONE IN NORTH
CAROLINA, 1897 TO 1907.

Year.	Value.
1897.....	\$ 11,500
1898.....	9,100
1899.....	10,300
1900.....	27,210
1901.....	11,682
1902.....	4,825
1903.....	600
1904.....	250
1905.....	4,482
1906.....	3,431
1907.....	4,105

MARBLE AND OTHER FORMS OF LIMESTONE.

PRODUCTION.

The production of limestone in North Carolina is used for two purposes: for burning to lime and for road building, and the value of the production for each purpose is approximately the same. In 1907 the total value of the production of limestone was \$46,338, of which \$22,328 was the value of the limestone used for road building. The 1907 production was obtained from New Hanover, Buncombe, Henderson and Transylvania counties, given in the order of the value of their production. Considering the quantity of lime that is used in North Carolina for building purposes and as a fertilizer, there should be a much larger amount quarried in the State, but one of the main reasons against this is the high freight rates on the lime from the quarry to point of consumption.

Efforts are now being made to interest capital in the opening up of the marble quarries in Swain County. These are adjacent to the Murphy branch of the Southern Railway. The marble quarries of McDowell County, which are about 10 to 15 miles north of Marion and the same distance from the Southern Railway, will be in close proximity to railroad transportation when the new railroad that is being constructed from Tennessee to Marion is finished. These deposits of marble have been described in detail on pages 200 and 202 of Bulletin 2.

There is given in the following table the value of the production of limestone from 1901 to 1907, inclusive:

PRODUCTION OF MARBLE AND OTHER
FORMS OF LIMESTONE, 1901-1907.

Year.	Value.
1901-----	\$ 8,357
1902-----	23,153
1903-----	25,365
1904-----	19,887
1905-----	29,015
1906-----	72,051
1907-----	46,338

SAND AND GRAVEL.

The only figures given under this head are those that could be obtained in regard to sand or gravel used by moulders, and that reported as the production during 1907 was 3,205 tons, valued at \$2,191, as compared with 843 tons, valued at \$491, the production reported for 1906. This does not represent all the sand used for this purpose, as a considerable amount has been used by foundrymen, which they obtained close by their shops and kept no special record of the quantity or of its cost.

The quantity of sand that is used in the manufacture of mortar for brick and stone work can be roughly estimated by the amount of stone and brick used. Estimating this amount of sand at 1 ton per 1,000 brick, it would give, approximately, 250,000 tons of sand used for this purpose. Besides the above, there is a large amount of sand used in the manufacture of plaster of which it is almost impossible to give even an approximate estimate.

Another use for gravel and also crushed stone that is constantly increasing is in the manufacture of concrete. The use of this form of construction is rapidly growing in North Carolina.

There are, undoubtedly, in eastern North Carolina certain sands of sufficient purity that could be used in the manufacture of glass. One of the requisites of such sand is that it must not contain any elements that would give the slightest degree of color to the resulting glass. It is sometimes possible to commercially purify certain sands and make them adaptable for the manufacture of glass.

SAND-LIME BRICK.

In the report for 1905 there was given a rather complete description of sand-lime brick and their manufacture. The demand for these artificial bricks is increasing, and eastern North Carolina, with its large amount of available sand, offers some of the more favorable

opportunities for the manufacture of such brick. The production of these brick in the State during 1907 amounted to 4,823,000 brick, valued at \$38,808, of which 4,068,000 were common brick, valued at \$29,458, and 755,000 were front brick, valued at \$9,350. This production was made by three producers located in Scotland, New Hanover and Buncombe counties, given in the order of the value of their production. In the following table there is given the production of sand-lime brick in North Carolina for the past four years:

PRODUCTION OF SAND-LIME BRICK IN NORTH CAROLINA, 1904-1907.

Year.	Common Brick.		Front Brick.		Total Value.
	Number.	Value.	Number.	Value.	
1904-----	1,800,000	\$ 17,500		\$-----	\$ 17,500
1905-----	3,185,000	20,953	660,000	8,150	29,103
1906-----	3,147,000	22,225	750,000	10,750	32,975
1907-----	4,068,000	29,458	755,000	9,350	38,808

CLAY.

Although there was a considerable increase in the production of clay products in North Carolina in 1907 as compared with the previous year, yet, considering the amount of fancy, pressed and vitrified brick, porcelain ware, pottery, earthen and stoneware and tiling, sewer pipe and terra cotta that are imported annually into the State, there is room for a much larger increase and development in the clay industry of the State. There is no doubt but that western North Carolina offers a very favorable location for a porcelain-ware manufacturing plant, inasmuch as there is produced each year in western North Carolina from \$75,000 to \$100,000 worth of kaolin of the porous variety, all of which is now being shipped out of the State. This would assure a supply of the finer grade of raw material, and other clays are abundant that would be suitable for other parts of the work; and then, again, there is water power available. Quartz and feldspar could also be obtained in western North Carolina, where there would be the additional advantage of being able to grind them by water power.

Taking all these conditions into consideration, it does seem as though such a manufacturing plant would be a most profitable investment.

Another branch of the clay product industry which is capable of much further development is the manufacture of a better quality of brick for general building purposes. There are being annually produced in North Carolina hundreds of thousands of common brick that will not stand transportation, and of course they bring but the lowest price per thousand in the market.

The total value of all clay products manufactured in North Carolina in 1907 amounted to \$1,316,308. If the value of the kaolin produced in the State during this time is added to this, it makes the total value of the clay industry in the State for 1907 amount to \$1,401,813. As compared with the value (\$1,272,796) of 1906, this is an increase of \$119,017.

KAOLIN.

PRODUCTION.

There was a falling off in the production of kaolin during 1907, due principally to the general trade depression of the latter six months of the year. Up to this time the demand for the kaolin had been better than the year before. The production during the year amounted to 11,035 pounds, valued at \$85,505. As compared with 11,803 tons, valued at \$90,036, the production of 1906, it is a decrease of 768 tons in quantity and of \$14,531 in value. If the trade conditions had been uniform throughout the year, the production of 1907 would have been much larger than that of the previous year. The average value per ton of the 1907 production was \$7.75, an increase of 12 cents, as compared with \$7.63, the average value received for the 1906 production. This kaolin was obtained from Jackson, Mitchell and Swain counties, the former being the larger producer. The Mitchell County deposits are on Bear Creek about one-half mile of Penland, a station on the South and Western Railroad, and began shipping ore in November, 1907.

POTTERY CLAY.

The decline noted in the pottery industry in North Carolina for the past year was continued in 1907, and the value of \$10,222 of the production for the year was a decrease of \$1,548, as compared with \$11,770, the value of the 1906 production. Although this production was small, it was divided amongst 25 manufacturers in the following 7 counties, given in the order of the importance of their production: Catawba, Buncombe, Randolph, Lincoln, Union, Wilkes and Johnston. Moore County, which was a producer in 1906, made no report of any production in 1907. Of this 1907 production, \$2,382 was the value of red earthenware and \$7,840 was the value of stoneware. In the following table there is given the value of the different grades of pottery produced in North Carolina in 1906 and 1907 by counties:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA BY COUNTIES
IN 1905, 1906 AND 1907.

County.	1905.			1906.			1907.		
	Earthen-ware.	Stone-ware.	Total.	Earthen-ware.	Stone-ware.	Total.	Earthen-ware.	Stone-ware.	Total.
Buncombe-----	\$ 125	\$2,725	\$2,850	\$ 100	\$1,325	\$1,425	\$ 150	\$2,184	\$ 2,334
Catawba-----		1,930	1,930	135	4,600	4,735	1,392	1,800	3,192
Chatham-----		500	500						
Johnston-----	100	150	250	50	40	90	100		100
Lincoln-----	20	2,059	2,079		1,757	1,757	100	1,100	1,200
Moore-----		100	100	50	100	150			
Randolph-----		790	790	150	1,495	1,645	435	1,496	1,931
Union-----	100	2,400	2,500	178	740	918	165	750	915
Wilkes-----	42	2,278	2,320	30	1,000	1,030	40	510	550
Total-----	387	12,932	13,319	713	11,057	11,770	2,382	7,840	10,222

The next table shows the total value of the pottery produced in North Carolina from 1900 to 1907, inclusive:

PRODUCTION OF POTTERY IN NORTH
CAROLINA, 1900-1907.

Year.	Value of Pottery.
1900-----	\$ 18,863
1901-----	22,495
1902-----	14,512
1903-----	14,312
1904-----	13,900
1905-----	13,319
1906-----	11,770
1907-----	10,222

There is each year a small amount of pottery clay sold crude, and in 1907 this amounted to 193 tons, valued at \$143, and was obtained from Buncombe, Catawba, Lincoln and Randolph counties.

FIRE CLAY AND PIPE CLAY.

Under this head are included fire and pipe clays and the products manufactured from them, as fire brick, sewer pipe, drain tile, fancy tile, flue linings, terra cotta, etc. In 1907, the total value of all these products reported to the Survey office was \$146,033, this being an increase of \$25,068, as compared with \$120,965, the value of the 1906 production. Of the 1907 production, \$3,490 was for the value of 194,000 fire brick manufactured in Buncombe County, and 110 tons of fire clay, valued at \$543, obtained from Buncombe and Davidson counties. There is given in the following table the production of fire-clay and pipe-clay products from 1901 to 1907, inclusive, and shows the constant increase in the value of this industry during this time:

PRODUCT ON OF FIRE-CLAY AND PIPE-CLAY PRODUCTS IN NORTH CAROLINA,
1901-1907.

Year.	Fire Brick.		Sewer Pipe, Tile, Etc.	Crude Clay.	
	Quantity.	Value.		Tons.	Value.
1901	55,000	\$ 550	\$ 55,745		\$ 100
1902		1,203	72,618		215
1903	407,500	5,250	100,980	231	875
1904	163,000	2,700	110,800	80	700
1905	681,000	8,333	102,445	57	494
1906	401,000	7,180	113,900	19	185
1907	194,000	3,490	142,000	903	986

BRICK CLAY.

The production of common brick in North Carolina is dependent largely on the prosperity of the country, which determines to a certain extent the amount of building that will be carried on. There was a slight increase in the number of brick produced in North Carolina during 1907, and, with the exception of fire brick, the total number of brick manufactured amounted to 175,670,000, valued at \$1,159,610. This is an increase of 8,447,000 brick in quantity and of \$110,122 in value, as compared with 167,123,000 brick, valued at \$1,049,488, the production of 1906. There was a falling off in the production of brick in the latter half of the year, as compared with the first six months of 1907. Of this 1907 production, 174,750,000 were common brick, valued at \$1,150,185, which is an increase of 8,412,000 brick in quantity and of \$109,108 in value, as compared with 166,338,000 common brick, valued at \$1,041,078, the 1906 production. The average price received for the common brick in 1907 was \$6.58, which is 33 cents greater than the average value of 1906, which in turn was 42 cents greater than the average value received for the common brick of 1905. The lowest value per thousand reported as having been received for common brick during 1907 was \$3.50, which was the value reported for 200,000 brick in Iredell County. The highest value per thousand received for common brick was \$10, which was the value reported for 50,000 brick in Harnett County.

The number of pressed and fancy brick manufactured in 1907 was 770,000, valued at \$7,925, and of vitrified brick, 150,000, valued at \$1,500.

The table below shows the quantity and value of the common, pressed, vitrified and fire brick produced in North Carolina during the past four years:

PRODUCTION OF COMMON, PRESSED, VITRIFIED AND FIRE BRICK
IN 1904, 1905, 1906 AND 1907.

Character.	1904.		1905.		1906.		1907.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Common brick	143,988,850	\$795,494	153,610,000	\$896,289	166,338,000	\$1,041,078	174,750,000	\$1,150,185
Pressed brick	1,510,000	17,375	875,000	13,925	385,000	4,410	770,000	7,925
Vitrified brick	450,000	3,850	400,000	3,600	400,000	4,000	150,000	1,500
Fire brick----	163,000	2,700	681,000	8,333	401,000	7,180	194,000	3,490
Total----	146,091,850	819,419	155,566,000	922,147	167,524,000	1,056,668	175,864,000	1,163,100

The number of manufacturers engaged in making brick in 1907 was 192, which was 8 more than the number engaged in this business in 1906. There were 65 counties out of the 98 that made a production of brick in 1907, and of these Forsyth produced the largest number, amounting to 14,030,000 brick, valued at \$92,014. This county was also the largest producer in 1906, with a production of 14,277,000 brick, valued at \$82,796. By comparing the figures for the two years, it will be seen that there was a decided increase in the average value per thousand received for the 1907 production. The second largest producer in 1907 was Lenoir County, with a production of 8,950,000 brick, valued at \$55,875. Wayne County was third, with a production of 8,460,000. The county producing the smallest number of brick was Gates, with a production of 20,000 brick, valued at \$100.

There is given in the following tables the number and value of the different varieties of brick manufactured in North Carolina, by counties, for the years 1906 and 1907:

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING
1906, BY COUNTIES.

County.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified and Fire Brick.	Value.
Alamance.....	3,858,000	\$ 25,650		\$.....		\$.....
Anson.....	500,000	3,000				
Beaufort.....	2,783,000	16,700				
Bertie.....	21,000	147				
Bladen.....	350,000	2,450				
Buncombe.....	5,271,000	35,350	100,000	1,500	388,000	6,980
Burke.....	1,710,000	8,551				
Caldwell.....	1,200,000	7,200				
Catawba.....	3,800,000	23,500				
Chatham.....	300,000	1,500				
Chowan.....	1,000,000	7,500				
Cleveland.....	1,249,000	7,711				
Columbus.....	2,250,000	14,000				
Craven.....	1,900,000	11,400				
Cumberland.....	4,700,000	27,750				
Davidson.....	2,900,000	18,000				
Davie.....	225,000	1,238				
Duplin.....	926,000	5,622				
Durham.....	7,450,000	49,850	60,000	660		
Edgecombe.....	7,230,000	44,800				
Forsyth.....	14,077,000	80,796	200,000	2,000		
Franklin.....	1,000,000	7,000				
Gaston.....	6,535,000	43,348				
Greene.....	700,000	4,700				
Guilford.....	8,550,000	54,605				
Halifax.....	5,650,000	33,800				
Harnett.....	500,000	3,900				
Haywood.....	300,000	2,400				
Henderson.....	2,000,000	11,000	25,000	250	*400,000	4,000
Iredell.....	3,350,000	21,100				
Jackson.....	16,000	100				
Johnston.....	3,500,000	23,400				
Lenoir.....	9,000,000	55,850				
Lincoln.....	800,000	5,600				
McDowell.....	335,000	2,000				
Macon.....	150,000	750				
Madison.....	200,000	900				
Martin.....	20,000	100				
Mecklenburg.....	5,650,000	37,500				
Moore.....	1,700,000	11,500				
Nash.....	1,950,000	13,750				
New Hanover.....	3,500,000	21,000				
Onslow.....	150,000	1,010				
Orange.....	550,000	3,175				
Pasquotank.....	2,100,000	13,650				
Pender.....	600,000	3,600				
Perquimans.....	300,000	2,100				
Pitt.....	1,488,000	9,900				
Randolph.....	1,717,000	10,452			13,000	300
Robeson.....	3,052,000	21,759				
Rockingham.....	1,950,000	12,750				
Rowan.....	3,550,000	24,300				
Rutherford.....	675,000	4,187				
Scotland.....	200,000	1,200				
Surry.....	6,700,000	39,000				
Union.....	3,057,000	18,288				
Wake.....	4,397,000	26,342				
Washington.....	183,000	1,100				
Wayne.....	10,720,000	63,413				
Wilkes.....	700,000	3,700				
Wilson.....	5,250,000	34,125				
Total.....	166,338,000	1,041,078	385,000	4,410	801,000	11,280

*Vitrified brick.

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING
1907, BY COUNTIES.

County.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified and Fire Brick.	Value.
Alamance.....	5,715,000	\$ 38,325		\$		\$
Anson.....	500,000	3,500				
Beaufort.....	2,320,000	14,250				
Bertie.....	1,089,000	8,450				
Bladen.....	75,000	600				
Buncombe.....	2,443,000	15,521			194,000	3,490
Burke.....	1,450,000	7,000				
Cabarrus.....	5,010,000	37,560				
Caldwell.....	2,450,000	14,275				
Catawba.....	3,200,000	19,400				
Chatham.....	1,400,000	8,500				
Chowan.....	1,250,000	10,000				
Cleveland.....	1,060,000	6,980				
Columbus.....	2,166,000	16,000				
Craven.....	2,648,000	17,174				
Cumberland.....	3,765,000	24,365				
Davidson.....	700,000	5,600				
Davie.....	450,000	2,700				
Duplin.....	333,000	2,364				
Durham.....	6,520,000	44,957				
Edgecombe.....	3,150,000	21,650				
Forsyth.....	13,260,000	84,389	750,000	7,625		
Franklin.....	1,500,000	10,500				
Gaston.....	3,543,000	22,324				
Gates.....	20,000	100				
Granville.....	2,150,000	16,050				
Greene.....	500,000	4,000				
Guilford.....	6,620,000	41,245				
Halifax.....	6,550,000	44,800				
Harnett.....	400,000	2,800				
Henderson.....	6,500,000	42,500	20,000	300	150,000	1,500
Iredell.....	4,616,000	28,200				
Johnston.....	3,050,000	19,450				
Lee.....	150,000	850				
Lenoir.....	8,950,000	55,875				
Lincoln.....	2,127,000	14,002				
McDowell.....	133,000	1,100				
Macon.....	200,000	1,000				
Martin.....	95,000	670				
Mecklenburg.....	400,000	45,200				
Montgomery.....	800,000	5,000				
Moore.....	1,200,000	8,150				
Nash.....	4,000,000	28,000				
New Hanover.....	3,000,000	18,750				
Orange.....	535,000	3,913				
Pasquotank.....	2,200,000	14,275				
Pender.....	1,235,000	7,250				
Perquimans.....	200,000	1,400				
Person.....	300,000	2,400				
Pitt.....	2,150,000	15,000				
Randolph.....	3,505,000	18,768				
Robeson.....	1,227,000	8,250				
Rockingham.....	1,272,000	7,956				
Rowan.....	6,300,000	47,300				
Rutherford.....	1,272,000	7,956				
Scotland.....	50,000	500				
Stanly.....	233,000	1,400				
Stokes.....	145,000	1,049				
Surry.....	3,300,000	19,000				
Union.....	5,565,000	37,198				
Wake.....	6,240,000	41,515				
Wayne.....	8,460,000	51,500				
Wilkes.....	1,350,000	6,800				
Wilson.....	6,300,000	44,850				
Yadkin.....	80,000	560				
Total.....	174,750,000	1,150,185	770,000	7,925	344,000	4,990

In the next table are given the quantity and value of all the clay products produced in North Carolina for the years 1902 to 1907, inclusive:

VALUE OF CLAY PRODUCTIONS OF NORTH CAROLINA IN
1902, 1903, 1904, 1905, 1906 AND 1907.

	1902.		1903.		1904.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Common brick	131,611,700	\$694,827	136,822,900	\$731,802	143,988,850	\$ 795,494
Pressed brick	1,233,000	10,625	766,000	8,230	1,510,000	17,375
Vitrified brick	600,000	6,000	500,000	5,000	430,000	3,850
Fire brick	1,203	407,500	5,250	163,000	2,700	2,700
Earthenware	658	612	612	438	438	438
Stoneware	13,854	13,854	13,700	13,462	13,462	13,462
Decorated ware						
Sewer pipe, tile, etc.		72,618		100,989		110,800
	<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>	
Kaolin	13,322	108,105	8,605	76,000	9,110	76,670
Fire clay		215	231	875	202*	761
Total value		908,105		942,458		1,021,550

	1905.		1906.		1907.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Common brick	153,610,000	\$896,289	166,338,000	\$1,041,078	174,750,000	\$1,150,185
Pressed brick	875,000	13,925	385,000	4,410	770,000	7,925
Vitrified brick	400,000	3,600	400,000	4,000	150,000	1,500
Fire brick	681,000	8,333	401,000	7,180	194,000	3,490
Earthenware		387		713		2,382
Stoneware		12,932		11,057		7,840
Decorated ware						
Sewer pipe, tile, etc.		102,445		113,900		142,000
	<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>	
Kaolin	10,988	85,622	10,803	90,036	11,035	85,505
Fire clay	107*	519	207	322	903*	986
Total value		1,124,052		1,272,696		1,401,813

*Including ordinary stoneware clay sold crude.

As was stated last year, the statistics given in this table do not, perhaps, represent the total output of all the clay production of the State, for the reason that in some counties there are a few thousand brick made for local purposes regarding which it is extremely difficult or impossible to obtain statistics, this being especially true where the brick are not for sale, but are used directly by those manufacturing them.

SUMMARY.

In order to show more clearly the value of the mineral production of the State by counties, there is given in the table below the value of the productions in each county for the years 1906 and 1907. It will be seen from this table that 80 counties out of the 98 in the State made some mineral production:

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH CAROLINA
IN 1906 AND 1907.

County.	1906.			1907.		
	Mineral Pro- duction, Including Kaolin.	Clay Products, Except Kaolin.	Total.	Mineral Pro- duction, Including Kaolin.	Clay Products, Except Kaolin.	Total.
Alamance	\$	\$ 25,650	\$ 25,650	\$	\$ 38,325	\$ 38,325
Alexander	350		350	4,921		4,921
Alleghany	500		500	800		800
Anson		3,000	3,000	3,250	3,500	6,750
Ashe	4,970		4,970	2,750		2,750
Beaufort		17,300	17,300		14,250	14,250
Bertie		147	147		8,450	8,450
Bladen		2,450	2,450		600	600
Brunswick						
Buncombe	35,331	45,460	80,791	60,944	21,488	82,432
Burke	20,357	8,551	28,908	7,636	7,000	14,636
Cabarrus	24,742		24,742	1,522	37,560	39,082
Caldwell		7,200	7,200		14,275	14,275
Camden						
Carteret						
Caswell						
Catawba	10,418	28,280	38,698	6,455	22,617	29,072
Chatham		1,500	1,500	1,886	8,500	10,386
Cherokee	16,578		16,578	1,664		1,664
Chowan		7,500	7,500		10,000	10,000
Clay						
Cleveland	52,138	7,711	59,849	33,122	6,980	40,102
Columbus		14,000	14,000		16,000	16,000
Craven		11,400	11,400		17,174	17,174
Cumberland		27,750	27,750		24,365	24,365
Currituck						
Dare						
Davidson	1,355	18,000	19,355	6,504	6,050	12,354
Davie		1,238	1,238		2,700	2,700
Duplin		5,622	5,622		2,364	2,364
Durham		50,510	50,510		44,957	44,957
Edgecombe		44,800	44,800		21,650	21,650
Forsyth		82,796	82,796		92,014	92,014
Franklin	608	7,000	7,608	1,188	10,500	11,688
Gaston	1,844	43,348	45,192	4,650	22,324	26,974
Gates					100	100
Graham						
Granville	10,000		10,000	48,973	16,050	65,023
Greene		4,700	4,700		4,000	4,000
Guilford	6,603	167,677	174,280	7,441	183,545	190,986
Halifax		33,800	33,800		44,800	44,800
Harnett		3,900	3,900		2,800	2,800
Haywood	21,975	2,400	24,375	17,400		17,400
Henderson	48,267	15,250	63,517	11,463	44,300	55,763
Hertford						
Hyde						
Iredell	2,950	21,100	24,050	3,028	28,200	31,228
Jackson	90,995	100	91,095	90,940		90,940
Johnston		23,490	23,490		19,550	19,550
Jones						
Lenoir		55,850	55,850		55,875	55,875
Lincoln	6,310	7,357	13,667	6,500	15,265	21,765
McDowell	31,357	2,000	33,357	12,480	1,100	13,580
Macon	48,966	750	49,716	36,625	1,000	37,625
Madison	10,020		10,020	30,855		30,855
Martin		100	100		670	670
Mecklenburg	8,964	37,500	46,464	13,872	45,200	59,072
Mitchell	131,078		131,078	190,569		190,569
Montgomery	61,650		61,650	52,848	5,000	57,848
Moore	17,173	11,650	28,823	11,519	8,150	19,669
Nash	1,305	13,750	15,055	5,600	28,000	33,600
New Hanover	41,083	21,000	62,083	35,973	18,750	54,723
Northampton						
Onslow		1,010	1,010			
Orange	17,904	3,175	21,079	10,098	3,913	14,011
Pamlico						
Pasquotank		13,650	13,650		14,275	14,275
Pender		3,600	3,600		7,250	7,250
Perquimans		2,100	2,100		1,400	1,400
Person	56,779		56,779	30,973	2,400	33,373

VALUE OF MINERAL PRODUCTION BY COUNTIES—CONTINUED.

County.	1906.			1907.		
	Mineral Pro- duction, Including Kaolin.	Clay Products, Except Kaolin.	Total.	Mineral Pro- duction, Including Kaolin.	Clay Products, Except Kaolin.	Total.
Pitt.....	\$.....	\$ 9,909	\$ 9,909	\$.....	\$ 15,000	\$ 15,000
Polk.....	27,880		27,880	22,670		22,670
Randolph.....	7,500	12,617	20,117	300	20,704	21,004
Richmond.....	12		12			
Robeson.....		21,759	21,759		8,350	8,350
Rockingham.....	60,394	12,750	73,144	58,950	5,075	64,025
Rowan.....	447,753	24,300	472,053	475,269	47,300	522,569
Rutherford.....	25,110	4,187	29,297	17,659	7,956	25,615
Sampson.....						
Scotland.....	10,000	1,200	11,200	17,250	500	17,750
Stanly.....	10,150		10,150	50	1,400	1,450
Stokes.....	3,773		3,773	3,865	1,049	4,914
Surry.....	256,428	39,000	295,428	286,154	19,000	305,154
Swain.....	69,665		69,665	92,549		92,549
Transylvania.....	12,043		12,043	4,310		4,310
Tyrrell.....						
Union.....	5,035	19,206	24,241	521	38,113	38,634
Vance.....	13,100		13,100	8,400		8,400
Wake.....	475	26,342	26,817	5,478	41,615	46,993
Warren.....	23,653		23,653	46,478		46,478
Washington.....		1,100	1,100			
Watauga.....	916		916	30		30
Wayne.....	1,025	63,413	64,438	1,045	51,500	52,545
Wilkes.....	1,200	4,730	5,930	118	7,350	7,468
Wilson.....		34,125	34,125		44,850	44,850
Yadkin.....					500	500
Yancey.....	64,684		64,684	60,055		60,055
Unknown.....	1,575		1,575	2,014		2,014
Totals.....	1,824,941	1,182,660	3,009,601	1,857,414	1,316,308	3,173,722

As is seen from the above table, the following counties reported no production of mineral of any kind during 1907: Brunswick, Camden, Carteret, Caswell, Clay, Currituck, Dare, Graham, Hertford, Hyde, Jones, Northampton, Onslow, Pamlico, Richmond, Sampson, Tyrrell and Washington. Of these counties, the following reported a production in 1906: Onslow, Richmond and Washington. There were 2 counties, Gates and Yadkin, which reported a production in 1907, but not in 1906. There were only 52 counties of the 80 reporting a mineral production that reported anything besides clay products. Of the 65 counties reporting a production of clay, 29 counties did not report any other production. There were 11 counties reporting a mineral production which did not include any clay products.

The county whose mineral production, except clay products, was the largest was Rowan, with a value of \$475,269. Guilford County reported the greatest value of clay products, which was \$183,545. The county reporting the greatest value for its total mineral production in 1907 was Rowan, with a value of \$522,569. The lowest value reported by any county for its mineral production was \$30, in Watauga.

